

SOIL SURVEY

Boone County Missouri



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
MISSOURI AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Boone County will help you plan the kind of farming that will protect your soils and provide good yields. It describes the soils, shows their location on a map, and tells what they will do under different kinds of management.

Find your farm on the map

In using this report, start with the detailed map that accompanies it. The map has seven sheets. At the lower right-hand side of each sheet, there is a small index map of the county that will help to show which sheet your farm is on. Towns and villages, roads, streams, and other landmarks shown on the detailed map will also help you locate your farm. Each soil is shown by a symbol, such as Fa, and the extent of each area is shown by a boundary line. All areas marked with the same symbol are the same kind of soil wherever they appear on the map. Color patterns help you pick out the areas of different soils; each color pattern is used for several soils that resemble each other in some way.

Suppose you have found on your farm an area marked with the symbol Fa. You learn the name of the soil this symbol represents by looking at the map legend. The symbol Fa identifies Freeburg silt loam, dark-surface variant.

Learn about the soils on your farm

Freeburg silt loam, dark-surface variant, and all the other soils mapped in the county are described in the section "Descriptions of the Soils." Soil scientists walked over the county day by day, and they described and mapped the soils. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noted differences in growth of crops, weeds, brush, or trees; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming.

After they mapped and studied the soils, the scientists talked with farmers and others about the use and management each soil should

have. Then they placed each soil in a capability class and in a capability unit. The capability classification is a means of showing the comparative suitability of the soils for agricultural use. A capability unit is a group of similar soils that need and respond to about the same kind of management.

Freeburg silt loam, dark-surface variant, is in capability unit IIIe-5. Turn to the section "Use and Management of the Soils" and read what is said about soils of unit IIIe-5. You will want to study the table that tells you what yield of crops you can expect from Freeburg silt loam, dark-surface variant, under two levels of management.

The "Guide to Mapping Units and Capability Units" at the back of the report gives the map symbol for each soil, the name of the soil, and the capability unit in which it has been placed.

Make a farm plan

For the soils on your farm, compare your yields and farm practices with those given in this report. Look at your fields for signs of runoff and erosion. Then, decide whether or not you need to change your methods. The choice, of course, must be yours. This survey will aid you in planning new methods, but it is not a plan of management for your farm or any other farm in the county.

If you find that you need help in farm planning, consult the local representative of the Soil Conservation Service or the county agricultural agent. Members of the staff of your State agricultural experiment station and others familiar with farming in your county will also be glad to help you.

Farmers can also obtain technical help on their soil conservation work from the staff that assists the Boone County Soil Conservation District. A soil map furnishes basic facts for use in working out the conservation measures that will control runoff and erosion on each farm.

* * * * *

Fieldwork for this survey was completed in 1951. Unless otherwise specified, all statements in the report refer to conditions in Boone County at that time.

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SOIL SURVEY OF BOONE COUNTY, MISSOURI

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE
MISSOURI AGRICULTURAL EXPERIMENT STATION

General Nature of the County

BOONE COUNTY is near the central part of Missouri (fig. 1). It is bordered on the south by the Missouri River. The northern edge of the county extends into the



Figure 1.—Location of Boone County in Missouri.

level prairie region of northeastern Missouri. The general slope is to the south, and the gradient is about 6 feet per mile. All drainage, except in a small area in the northeastern corner, is into the Missouri River. The total land area of the county is approximately 683 square miles, or 437,120 acres.

Columbia, the county seat, is about midway between St. Louis on the east and Kansas City on the west. The University of Missouri, Stephens College, and Christian College are located in this city.

Population

According to the Federal census, the population of Boone County was 48,432 in 1950 and 55,202 in 1960. The population of Columbia for the same years was 31,974 and 36,650, respectively. Centralia had a population of 3,200 in 1960. These two cities have more than 70 percent of the total population of the county.

Physiography and Relief

The northeastern part of Boone County, between Centralia and Sturgeon, is a level plain that has an average elevation of 850 to 900 feet above sea level. A long, narrow arm of this plain extends southward from Centralia through Hallsville and Murry and terminates at Ashland. Hallsville and Ashland also have an average elevation of 850 and 900 feet.

The northwestern part of the county is completely dissected and moderately hilly, but the relief from valley floor to ridgetop is rarely more than 100 feet. Perche Creek has a fall of 150 feet in an airline distance of about 29 miles extending from the northern border of the county to the Missouri River. Such a gradient indicates that the streams in the county are still cutting downward.

The central part of the county is rolling, and there are steep slopes along the larger streams. Columbia is at an elevation of about 750 feet above sea level.

The southern part of the county, to the east, south, and west of Ashland, is hilly and completely dissected, as shown in figure 2. Variation in local relief is as much as 200 feet. The most rugged land surface is a band, 2 to 4 miles wide, of steep hills bordering the Missouri River. The boundaries of these topographic areas are gradational and arbitrary. The lowest part of the county, at an elevation of about 540 feet, is on the flood plain of the Missouri River at the extreme southern tip of the county.

During the Kansan glacial stage of Pleistocene time, almost all of the county was covered by glacial material. This material ranges in thickness from a few feet to more than 100 feet. The thickest material occurs in the northern and eastern two-thirds of the county. The glacial till consists of yellowish clay mixed with sand and small pebbles.

At a later time following glaciation, loess (wind-blown silt) was deposited over the entire county. It is thickest on the bluffs along the Missouri River and gradually becomes thinner with distance from the river. Over large areas, especially in the northwestern and eastern parts of the county, the cover of loess has been removed by erosion and the underlying glacial till forms the present land surface.

Boone County is in the transitional zone between the forest region to the east and the prairie region to the north and west. Approximately 20 percent of the county was originally covered with prairie grasses. The prairie

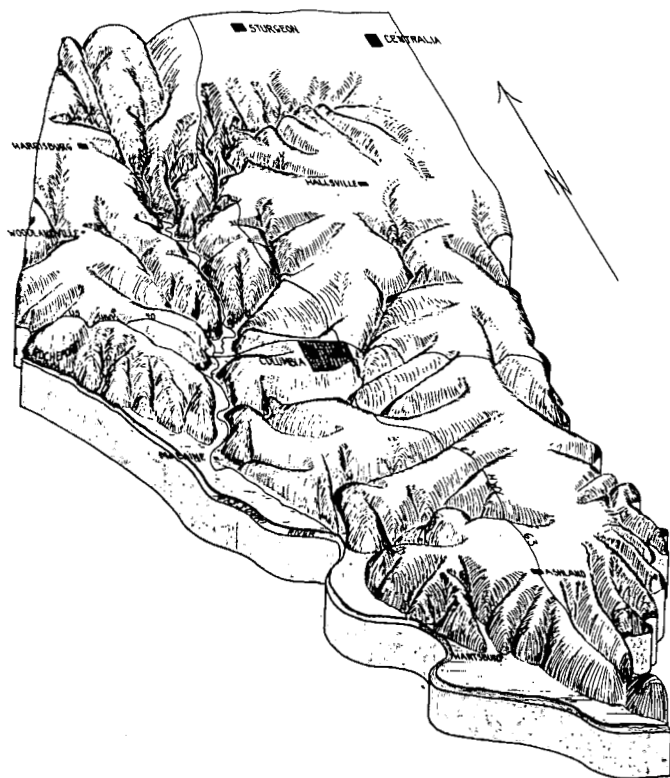


Figure 2.—Relief and drainage in Boone County.

cover was most extensive on the level area in the northeastern part of the county. Relief, parent materials, and vegetation were important soil-forming factors in the county. The relation of all the soil-forming factors is discussed more fully in the section "Genesis, Classification, and Morphology of the Soils."

Water Supply

Both surface and underground water are abundant in Boone County. With minor exceptions, the soils retain moisture well. The average annual precipitation is about 38 inches. There are about 100 miles of perennial streams.

Many ponds supply water for domestic use. Approximately 700 ponds were constructed between 1949 and 1959. Because they contain much clay, the soils are especially suitable for ponds. Underground water of good quality is abundant. Large amounts occur at a depth of 1,000 or more feet.

Irrigation

The feasibility of irrigating land in Boone County is determined primarily by the available water supply. Because of favorable soils and a good supply of water, the bottom lands of the Missouri River are most suitable for irrigation. Here, there is an abundance of water at a depth of 20 to 30 feet. The small perennial streams do not have enough flow to irrigate a large area. Small reservoirs have a similar limitation. Irrigation from deep wells is seldom economically feasible in this area.

Most soils of the uplands tend to become compact and hard if irrigated regularly for several years. Frequent wetting tends to destroy aggregation of soil particles.

Mineral Resources

Boone County has an abundance of limestone that is suitable for agricultural lime. The entire southwestern part of the county is underlain by high-grade limestone, mainly of Mississippian age. The limestone is covered with a thick mantle of till and loess, but there are many exposures suitable for quarry sites. Large quarries are located near Columbia and elsewhere in the county. More than 20,000 tons of agricultural limestone have been applied annually to soils in the county for many years.

An area about 10 miles wide, extending southeastward from Harrisburg to a point east of Columbia, is underlain by coal of possible commercial quality and quantity. Pit mining has been discontinued, but some strip mining is done. The larger strip areas, which are shown on the detailed soil map, are about 3 miles southeast of Harrisburg and about 3 miles northeast of Columbia.

Climate

The climate of Boone County is characterized by warm summers and cool winters. Precipitation is fairly evenly distributed throughout the year, but large amounts of rainfall occur in summer and fall, particularly in June and September. The data in table 1 on temperature and precipitation in Boone County were compiled from records of the U.S. Weather Bureau Station at Columbia.

Precipitation averages slightly less than 2 inches per month during the winter, gradually increases through the spring months, and reaches a maximum of nearly 5 inches in June. July and August have about 3.5 to 3.9 inches of rainfall, and September has about 4.3 inches. Precipitation tapers off during the rest of the fall months.

Droughts are uncommon, although occasional dry periods in the summer reduce yields of crops. In winter, precipitation occurs as rain, snow, or ice; winter pastures are occasionally covered for a week.

The average date of the first frost is October 19. The average date of the last frost in spring is April 10. Boone County has an average growing season of 192 days.

Agriculture

Boone County is mainly agricultural. A total of 386,878 acres, or 88.5 percent of the county, was in farms in 1954.¹ About 32 percent of the farmland was harvested for crops, and 54 percent was pastured. The large percentage of pasture is attributed to the extensive areas of soils that are not well suited to cultivation. From 1949 to 1954, there was an increase of 8 percent in total land pastured. This shift has been due to the marginal quality of some of the land formerly cultivated, to low fertility, and to the hazard of erosion on cultivated soils.

¹ Statistics given in this section are based on the Federal census.

TABLE 1.—*Temperature and precipitation at Columbia, Boone County, Missouri*

[Elevation, 778 feet]

Month	Temperature ¹			Precipitation ²			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1953)	Wettest year (1927)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December.....	33.9	75	-12	1.82	1.06	1.94	3.2
January.....	30.3	77	-18	1.89	1.36	1.75	4.4
February.....	33.1	76	-9	1.82	1.51	.57	2.6
Winter.....	32.4	77	-18	5.53	3.93	4.26	10.2
March.....	43.3	85	-5	2.89	3.66	7.65	4.7
April.....	54.9	90	20	3.68	2.86	5.17	.5
May.....	64.5	93	33	4.73	2.66	6.68	(³)
Spring.....	54.2	93	-5	11.30	9.18	19.50	5.2
June.....	73.7	102	41	4.73	1.06	6.11	0
July.....	78.0	113	49	3.47	2.68	3.07	0
August.....	76.7	103	46	3.85	2.82	5.01	0
Summer.....	76.1	113	41	12.05	6.56	14.19	0
September.....	69.1	102	29	4.29	2.72	2.38	0
October.....	57.9	92	21	2.90	2.31	5.08	(³)
November.....	44.0	82	4	2.24	.42	4.29	1.3
Fall.....	57.0	102	4	9.43	5.45	11.75	1.3
Year.....	54.9	113	-18	38.31	25.12	49.70	16.7

¹ Average temperature based on a 55-year record, through 1959; highest and lowest temperatures, on a 20-year record, through 1959.² Average precipitation based on a 55-year record, through 1959; wettest and driest years based on a 55-year record, in the period 1905-1959; snowfall based on an 11-year record, through 1959.³ Trace.

Livestock

In Boone County the acreage in pasture has always been large, and livestock has been a main source of income. Although 32 percent of the farmland was harvested for crops in 1954, most of the crops were fed to livestock instead of being sold for cash. Table 2 gives the number of livestock on farms of the county in stated years.

TABLE 2.—*Number of livestock on farms in stated years*

Livestock	1940	1950	1954
Cattle and calves.....	¹ 24,772	31,615	42,260
Milk cows.....	6,505	6,802	4,956
Hogs and pigs.....	² 23,883	44,445	39,741
Sheep and lambs.....	³ 23,577	26,420	15,109
Horses and mules.....	¹ 8,523	5,109	2,189
Chickens.....	² 193,667	² 165,682	² 146,565
Turkeys raised.....	50,710	16,277	16,216

¹ Over 3 months old.³ Over 6 months old.² Over 4 months old.

Crops

Acreages of principal crops grown in Boone County in stated years are given in table 3.

TABLE 3.—*Acreages of principal crops in stated years*

Crop	1939	1949	1954
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn for all purposes.....	41,784	39,524	42,526
Wheat threshed or combined..	10,903	14,617	14,048
Oats threshed or combined....	7,018	5,431	9,142
Soybeans for all purposes.....	6,947	8,872	26,782
All hay.....	27,246	37,884	26,195
Alfalfa.....	2,395	1,846	3,698
Clover and timothy.....	14,027	8,043	7,846
Lespedeza.....	6,244	23,879	¹ 2,689
Other hay crops.....	4,580	4,116	11,962

¹ In addition, 1,961 acres of lespedeza were harvested for seed and a major part of the 66,058 acres of cropland used only for pasture was in vegetation consisting mainly of lespedeza.

Corn was grown on about 20 percent of the total cropland in 1954. It was being grown in all parts of the county but most extensively on soils of the bottom lands and the uplands in prairie areas. About 12 percent of the total cropland was used for hay, about 31 percent was pastured, about 10 percent was not harvested or pastured, and about 24 percent was used for wheat, oats, and soybeans.

Since 1929 the acreage in corn has decreased about 20 percent; most of this acreage has been diverted to pasture. Average yields of corn are increasing, however. Soybeans are increasing in importance. They grow well on some of the nearly level soils that have slow internal drainage. The total acreage in hay has not changed significantly, but the acreage in the major kinds of hay has shifted through the years.

Minor crops that are important in certain localities are tobacco and fruit. These are grown mainly on Menfro and Winfield soils of the river hills. In 1954 there were 52 acres in tobacco and 465 acres in orchards. The Salix, Sharon, and Ray soils on the bottom lands are well suited to growing vegetables.

Woodland

About 19 percent, or 72,502 acres, of the total farmland was reported as woodland in 1954. This was an increase of 14,793 acres over the 57,709 acres reported in 1949. Most of the woodland is on the steeper slopes of the Lindley, Menfro, Winfield, and Union soils. Opportunities for establishing more woodlots are excellent, and the woodlots are desirable for the control of erosion. The dominant tree is white oak. Elm, maple, basswood, walnut, hackberry, and other species are abundant on the soils of the river hills.

Agricultural practices

Production of all crops has increased through soil treatment and the growing of improved varieties. Fertilizer is used on most of the grain crops. Limestone is used extensively and is obtained from quarries in the

county. Little improvement has been made on pastures. Experiments in Boone County have shown that, by the addition of lime and fertilizer and reseeding with mixtures of grasses and legumes, the carrying capacity of most of the pastures could be doubled. Because a large part of the farmland in Boone County is used for pasture, pasture improvement is necessary.

Erosion is a major problem on the soils of the uplands. Methods of control, other than maintaining a cover of vegetation, have been used to a limited extent. Little land has been terraced or stripcropped. Planting and cultivating on the contour have been practiced more extensively, however.

Practically all of the creek and river bottom lands are subject to occasional flooding. This has no significant effect on land use. Some of the bottom lands of the Missouri River are protected from low floods by levees. During high floods, which may not occur for a period of 10 to 20 years, all of the bottom lands may be inundated. Low-lying areas may be flooded every 2 or 3 years.

Type, tenure, and size of farms

In 1954 there were 2,446 farms in Boone County. The farms were grouped as follows:

	<i>Number</i>
Livestock -----	1,037
Field crop -----	287
Dairy -----	83
Poultry -----	60
General -----	128
Fruit and nut -----	5
Miscellaneous and unclassified -----	846

Dairy farms are most numerous around Columbia. A total of 843 farm operators received most of their income from sources other than the farm in 1954. About 280 farms were operated by tenants. The average size of farms has increased, whereas the total number of farms has decreased. The average size of farm increased from 121.7 acres in 1920 to 158.2 acres in 1954.

Descriptions of the Soils

The soil scientists who made this survey went over the area at appropriate intervals and examined the soils by digging with a spade or auger. In each boring they examined the different layers, which soils men call horizons, and they compared the different borings. By such comparisons, they determined the different kinds of soils in the area.

They described the various soils and drew boundaries on aerial photographs to show the extent of them. The soils are described in approximate alphabetic order in the following pages. Their acreage and proportionate extent are shown in table 4, and their location can be seen on the detailed map that accompanies this report.

Soils are classified by series, types, and phases. A soil series is given a place name; for example, the Mexico soils are so named because they were first mapped near Mexico, Mo. The soils of a series resemble each other in many ways but may differ somewhat in texture of the

surface soil. A soil type is named by adding texture of surface soil to the series name; for example, Mexico silt loam. Most of the soil mapping units are phases of soil types. These soil phases are named by adding information about slope, degree of erosion, or other details to the name of the soil type.

An important part of each soil description is the soil profile, a record of what the soil scientist saw and learned when he dug into the ground. All soils of one type have essentially the same kind of profile, and soil types of the same series differ only in the texture of the surface layer. Thus, it is not necessary to describe, in detail, the profile of each soil shown on the map.

Following the name of each soil, there is a set of symbols in parentheses. These symbols identify the soil on the detailed map. The capability unit is given for each mapping unit, and these units are described in the section "Use and Management of the Soils."

In describing the soils, the scientist frequently assigns a symbol, for example "A₁," to the various layers. These symbols have a special meaning that concerns scientists and others who desire to make a special study of soils. Most readers will need to remember only that all symbols beginning with "A" indicate surface soil and subsurface soil; those beginning with "B" indicate subsoil; those beginning with "C" indicate substratum, or parent material; and those beginning with "D" indicate any layer under the "C" that does not consist of material from which the soil formed.

In some soils of the bottom lands, it is difficult to determine whether the soil layers are surface soil, subsoil, or parent material. For these soils, the layers are numbered consecutively and are not assigned a symbol.

The color of a soil can be described in words, such as "yellowish-brown," and can also be indicated by symbols for the hue, value, and chroma, such as "10YR 5/4." These symbols, called Munsell color notations, are used by soil scientists to evaluate soil colors precisely. For the profiles described in this report, color names and color symbols are given for moist soil, unless otherwise stated.

The texture of the soil refers to the content of sand, silt, and clay. It is determined by the way the soil feels when rubbed between the fingers, and it is later checked by laboratory analyses. Each mapping unit is identified by a textural name, such as "fine sandy loam." This refers to the texture of the surface soil.

Structure is indicated by the way the individual soil particles are arranged in larger grains, or aggregates, and the amount of pore space between the grains. The structure of the soil is determined by the strength or grade, the size, and the shape of the aggregates. For example, a horizon may have "weak, fine, blocky structure."

Carlów silty clay, high-bottom phase (Ca).—This is a moderately dark, fine-textured, level soil. It occurs on the high bottoms in the lower end of the valley of Perche Creek and in other creek valleys. It is of minor extent.

The surface layer is dark-gray silty clay, about 12 inches thick, that in some places contains small iron concretions. Below this layer is very dark gray silty clay that grades to clay at a depth of about 40 inches. This layer may contain mottled colors of brown and yellow. When wet, both the surface layer and subsoil are sticky and plastic. When dry, they are hard and cloddy.

TABLE 4.—Approximate acreage and proportionate extent of the soils

Map symbol	Soil	Acres	Percent	Map symbol	Soil	Acres	Percent
Ca	Carlow silty clay, high-bottom phase.	423	0.1	Pb	Putnam silt loam, 0 to 2 percent slopes.	16,762	3.8
Cb	Chauncey silt loam, 0 to 1 percent slopes.	3,391	.8	Ra	Raccoon silt loam, 1 to 3 percent slopes.	3,975	.9
Da	Dennis silt loam, 3 to 7 percent slopes.	615	.1	Rb	Ray silt loam.....	3,215	.7
Fa	Freeburg silt loam, dark-surface variant.	2,735	.6	Rc	Riverwash.....	1,583	.4
Ga	Gamma soils, 5 to 8 percent slopes..	391	.1	Sa	Salix loam.....	653	.2
Gb	Gamma soils, 9 to 12 percent slopes..	1,913	.4	Sb	Sapp soils, 3 to 5 percent slopes.....	5,943	1.4
Gc	Gara loam, 5 to 8 percent slopes.....	3,343	.8	Sc	Sarpy sand.....	369	.1
Gd	Gara loam, 5 to 9 percent slopes, moderately eroded.	21,096	4.8	Sd	Sarpy loamy fine sand.....	1,542	.4
Ge	Gara clay loam, 5 to 9 percent slopes, severely eroded.	1,978	.5	Se	Sarpy very fine sandy loam.....	6,420	1.5
Gf	Gosport stony silt loam, 11 to 30 percent slopes.	2,495	.6	Sf	Seymour silt loam, 2 to 4 percent slopes.	3,036	.7
Ha	Hatton silt loam, 3 to 7 percent slopes.	9,244	2.1	Sg	Seymour silt loam, 3 to 7 percent slopes, moderately eroded.	1,712	.4
La	Lindley loam and clay loam, 5 to 8 percent slopes.	49,237	11.3	Sh	Sharon silt loam.....	15,175	3.5
Lb	Lindley loam and clay loam, 9 to 15 percent slopes.	44,699	10.2	Sk	Sharon silt loam, gravel-substratum variant.	2,160	.5
Lc	Lindley loam, 16 to 25 percent slopes.	4,064	.9	Sl	Snead silty clay, 7 to 12 percent slopes.	332	.1
Ma	Mandeville silt loam, 5 to 8 percent slopes.	3,689	.8	Sm	Snead stony clay loam, 11 to 30 percent slopes.	775	.2
Mb	Mandeville silt loam and silty clay loam, 9 to 16 percent slopes.	3,207	.7	Sn	Steep stony land, 15 to 50 percent slopes.	27,552	6.3
Mc	Marion silt loam, 1 to 3 percent slopes.	3,232	.7	So	Stet silt loam.....	297	.1
Md	Menfro silt loam, terrace phase, 1 to 3 percent slopes.	321	.1	Sp	Strip mines.....	566	.1
Me	Menfro silt loam and silty clay loam, 6 to 13 percent slopes.	8,657	2.0	Ua	Union silt loam, 3 to 8 percent slopes.	3,170	.7
Mf	Menfro silt loam and silty clay loam, 14 to 19 percent slopes.	4,198	1.0	Ub	Union silt loam and silty clay loam, 9 to 16 percent slopes.	12,740	2.9
Mg	Menfro silt loam and silty clay loam, 20 to 50 percent slopes.	13,656	3.1	Wa	Wabash silty clay loam.....	138	(¹)
Mh	Mexico silt loam, 1 to 3 percent slopes.	30,069	6.9	Wb	Wabash clay.....	189	(¹)
Mk	Mexico silt loam, 2 to 4 percent slopes, moderately and severely eroded.	22,424	5.1	Wc	Weldon silt loam, 2 to 4 percent slopes.	28,548	6.5
MI	Mexico silt loam, light-gray variant, 1 to 3 percent slopes.	13,380	3.1	Wd	Weldon silt loam, 2 to 4 percent slopes, moderately eroded.	3,085	.7
Mm	Moniteau silt loam.....	6,292	1.4	We	Weldon soils, 5 to 11 percent slopes..	1,365	.3
Oa	Onawa silty clay loam.....	3,016	.7	Wf	Westerville silt loam.....	12,639	2.9
Ob	Onawa silty clay.....	347	.1	Wg	Winfield silt loam, 6 to 13 percent slopes.	11,116	2.5
Pa	Pershing silt loam, 2 to 4 percent slopes.	1,930	.4	Wh	Winfield silty clay loam, 6 to 13 percent slopes, severely eroded.	2,312	.5
				Wk	Winfield soils, 14 to 19 percent slopes.	3,821	.9
				WI	Winfield soils, 20 to 30 percent slopes.	2,368	.5
					Water.....	3,520	.8
					Total.....	437,120	100.0

¹ Less than 0.1 of 1 percent of the total area.

Profile description (NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 30, T. 46 N., R. 13 W.):

- 0 to 13 inches, dark-gray (10YR 4/1), plastic silty clay stained with yellowish red (5YR 5/8); massive; contains scattered iron and manganese concretions.
- 13 to 40 inches, mottled very dark gray (10YR 3/1), dark-gray (10YR 4/1), and yellowish-brown (10YR 5/8), plastic silty clay; weak, medium, subangular blocky structure.
- 40 inches +, very dark gray (10YR 3/1), very plastic clay; a few mottles of yellowish brown (10YR 5/8); massive.

Use and suitability.—Corn is not well suited to this soil, because the clay subsoil drains slowly. Soybeans, small grains, and grass are more dependable crops. Results from the use of fertilizer vary.

This soil has been leached and damaged by poor drainage. It dries slowly and is difficult to cultivate. Al-

though it occurs on fairly high bottom lands, it is subject to overflow. In wet seasons tillage is difficult and planting may be delayed. Surface drainage through open ditches helps increase yields. (Capability unit IIw-14.)

Chauncey silt loam, 0 to 1 percent slopes (Cb).—This is a moderately dark, medium-textured, nearly level soil that has formed in materials washed from adjacent slopes. It occurs within areas of Putnam and Mexico soils, in places where the drainageways have comparatively wide bottoms.

The surface layer, to a depth of 16 to 18 inches, is very dark grayish-brown or dark-gray, friable silt loam that grades to dull-gray, friable silty material. At a depth of 30 to 40 inches, the subsoil is gray silty clay loam or silty clay, similar to the lower subsoil in the Putnam soil. In places small iron concretions occur throughout the profile.

Lateral movement of the ground water on the surrounding gentle slopes saturates the soil. The gray color of the thick subsurface layer results from prolonged saturation during wet seasons. The presence of iron and manganese concretions is also an indication of the poor drainage.

Profile description (NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, T. 51 N., R. 12 W.):

- A₁ 0 to 18 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, granular structure; contains some iron and manganese concretions.
- A₂ 18 to 34 inches, gray (10YR 6/1) silt loam mottled with grayish brown (10YR 5/2); weak, fine, granular structure.
- B₂ 34 to 42 inches +, gray (10YR 5/1) silty clay loam mottled with yellowish brown (10YR 5/6); massive; contains many iron and manganese concretions.

Use and suitability.—This soil is used mainly for pasture and meadow; timothy, redbud, and lespedeza are the main grasses. When adequately drained, the soil will produce good yields of corn, oats, and soybeans. Surface drainage is the major need. This soil is slightly more fertile than the Mexico silt loams, which in many areas occur on the adjacent slopes. (Capability unit IIIw-3.)

Dennis silt loam, 3 to 7 percent slopes (Dol).—This is a moderately dark colored, medium-textured, gently sloping soil of the uplands. It occurs in areas where the underlying shale and limestone are near the surface and are the soil-forming materials. It is of minor extent.

The surface layer is very dark gray, friable silt loam, 9 to 12 inches thick. This layer grades into dark grayish-brown, friable silty clay loam that is lighter in color and finer in texture with increasing depth. Yellowish mottled colors occur throughout the subsoil.

Profile description (SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 48 N., R. 12 W.):

- A 0 to 10 inches, very dark gray (10YR 3/1), friable silt loam; moderate, medium, granular structure.
- B₁ 10 to 13 inches, dark grayish-brown (10YR 4/2), friable silty clay loam; moderate, fine, subangular blocky structure.
- B₂ 13 to 25 inches, mottled yellowish-brown (10YR 5/6), dark-gray (10YR 4/1), and yellowish-red (5YR 5/6), slightly plastic silty clay; weak, medium, subangular blocky structure; some iron and manganese concretions.
- B₃ 25 to 40 inches, light-gray (10YR 7/1), plastic silty clay mottled with yellowish red (5YR 5/8) and dark gray (10YR 4/1); massive (structureless); many iron and manganese concretions.

Use and suitability.—This soil is well suited to clover and grass. Corn and bluegrass are the principal crops. The deep, mellow soil is easily tilled and is highly productive. (Capability unit IIIe-1.)

Freeburg silt loam, dark-surface variant (Fc).—This is a dark-colored, medium-textured, nearly level soil. It occurs on terraces in areas that are 10 to 15 feet higher than the adjacent bottom lands.

The surface layer is very dark grayish-brown silt loam, about 10 inches thick, that overlies a layer of lighter gray silt loam, about 6 inches thick. The silty clay loam subsoil, which begins at a depth of about 16 inches, is dark gray in the upper part and gray in the lower part. Mottles of yellowish brown occur throughout the subsoil.

The gray and mottled colors of the layers beneath the surface layer indicate slow internal drainage. Some areas receive seepage water from adjacent soils of the uplands.

In these wet areas, the subsoil is generally more dense and more highly mottled than elsewhere.

Profile description (NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 50 N., R. 13 W.):

- A₁ 0 to 10 inches, very dark grayish-brown (10YR 3/2), friable silt loam; moderate, medium, granular structure.
- A₂ 10 to 16 inches, grayish-brown (10YR 5/2), friable silt loam; weak, medium, granular structure; contains a few iron concretions.
- B₁ 16 to 24 inches, dark-gray (10YR 4/1), plastic silty clay loam mottled with yellowish brown (10YR 5/8); moderate, medium, subangular blocky structure.
- B₂ 24 to 36 inches +, gray (10YR 5/1), slightly plastic silty clay loam mottled with yellowish brown (10YR 5/8); weak, medium, subangular blocky structure.

Use and suitability.—This soil is medium in productivity and is well suited to cultivated crops. Corn is the major crop, but other grain crops are grown successfully. The deep surface soil is easily tilled. (Capability unit IIIe-5.)

Gamma soils, 5 to 8 percent slopes (Gc).—These are light-colored, medium-textured, sloping soils of the uplands. They are of minor extent and occur in the eastern part of the county, north of Englewood.

Uneroded areas normally have a dark grayish-brown, friable loam surface layer, about 5 inches thick, that overlies a layer of yellowish-brown, friable loam, about 3 inches thick. The upper subsoil is predominantly yellowish-red sandy clay loam with some grayish and reddish mottles. The lower subsoil contains more clay, and the mottled colors are grayer and browner. The redder colors are attributed to better aeration and oxidation of the loamy material.

On some slopes the subsoil is exposed, and in places the texture of the surface layer varies.

Profile description of Gamma loam (NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 47 N., R. 11 W.):

- A₁ 0 to 5 inches, dark grayish-brown (10YR 4/2), very friable loam; weak, fine, granular structure.
- A₂ 5 to 8 inches, yellowish-brown (10YR 5/4), very friable loam; weak, fine, granular structure.
- B₂₁ 8 to 18 inches, yellowish-red (5YR 4/8), friable sandy clay loam mottled with light brownish gray (10YR 6/2) and red (10R 4/6); weak, medium, subangular blocky structure.
- B₂₂ 18 to 36 inches, mottled yellowish-red (5YR 4/8) and light brownish-gray (10YR 6/2), firm sandy clay; contains flecks of red (10R 4/6); strong, medium and coarse, subangular blocky structure.
- B₃ 36 to 52 inches, mottled grayish-brown (10YR 5/2), strong-brown (7.5YR 5/8), and red (10R 4/6) sandy clay; massive (structureless).
- C 52 to 70 inches +, mottled brownish-yellow (10YR 6/6) and yellowish-red (5YR 5/8) sandy clay; massive (structureless).

Use and suitability.—These soils are used mainly for pasture because their short, dissected slopes are not well suited to cultivation. Bluegrass thrives, and pastures respond well to fertilization. The major problem is control of erosion. (Capability unit IIIe-6.)

Gamma soils, 9 to 12 percent slopes (Gb).—Uneroded areas of these soils have a profile similar to that described for Gamma soils, 5 to 8 percent slopes. These soils are more subject to erosion, however, because of their steeper slopes. This mapping unit is more extensive than Gamma soils, 5 to 8 percent slopes.

In many areas erosion has occurred in a spotted pattern. The A₁ horizon in these areas is generally thinner and yellower because it has been mixed, to some extent,

with the A₂ horizon. In a few small areas, all of the silty surface layer has been lost and the finer textured, reddish subsoil is exposed.

Use and suitability.—These soils are more restricted in use and require more intensive management than Gamma soils, 5 to 8 percent slopes. (Capability unit IVE-6.)

Gara loam, 5 to 8 percent slopes (Gc).—This is a moderately dark, medium-textured soil of the uplands. The largest areas are mainly in the northwestern part of the county; smaller areas occur throughout the county.

The surface layer is generally very dark grayish-brown, friable loam, about 10 inches thick. The upper part of the subsoil is very dark grayish-brown clay loam, whereas the lower part is grayer and more intensely mottled with reddish and yellowish colors. Where this soil occurs adjacent to the Mexico soils, its subsoil is browner and higher in content of clay.

Profile description (NW¼SE¼ sec. 16, T. 50 N., R. 12 W.):

- A₁ 0 to 10 inches, very dark grayish-brown (10YR 3/2), friable loam; moderate, medium, granular structure.
- B₁ 10 to 13 inches, very dark grayish-brown (10YR 3/2), friable clay loam; when dry, this horizon is dark grayish brown (10YR 4/2) with gray (10YR 6/1) coatings on peds; moderate, fine, subangular blocky structure.
- B₂ 13 to 20 inches, dark-brown (7.5YR 4/4), slightly plastic clay loam mottled with dark red (10R 3/6) and gray (10YR 5/1); moderate, fine, subangular blocky structure.
- B₃ 20 to 36 inches, gray (10YR 5/1), plastic clay loam mottled with yellowish red (5YR 4/8) and dark red (10R 3/6); weak, medium, subangular blocky structure.
- C 36 to 50 inches +, mottled gray (10YR 6/1) and brownish-yellow (10YR 6/8), plastic clay loam; massive (structureless).

Use and suitability.—Much of this soil is used for pasture. Bluegrass and clover thrive. Pastures that are not mowed are often covered with ironweed and buckbrush. Corn and small grains are grown, but yields are low unless fertilizer is used. Control of erosion is the major problem in cultivated fields and in pastures. (Capability unit IIIe-6.)

Gara loam, 5 to 9 percent slopes, moderately eroded (Gd).—This is the most extensive of the Gara soils. Because of moderate erosion, the A₁ horizon is generally about 5 inches thick. The plow layer is browner and tends to be slightly finer textured than that of the Gara loam, 5 to 8 percent slopes. This is the result of the mixing of part of the subsoil with the surface layer. In many of the cultivated fields, all of the B₁ horizon has been mixed with the plow layer, which has an abrupt boundary to the B₂ horizon of clay loam.

Use and suitability.—Most areas of this soil are cultivated. Corn and small grains are the principal crops. More restrictive use and more intensive management are needed to control erosion on this soil than on the uneroded or slightly eroded Gara soils on similar slopes. (Capability unit IIIe-6.)

Gara clay loam, 5 to 9 percent slopes, severely eroded (Ge).—This soil is of minor extent. Practically all of the original surface soil has been removed by erosion, and the plow layer consists mainly of clay loam subsoil.

Use and suitability.—This soil generally has less infiltration of water, more surface runoff, and lower fertility

than the less eroded Gara soils. Consequently, it is less productive and needs more restrictive use and more intensive management. (Capability unit IVE-6.)

Gosport stony silt loam, 11 to 30 percent slopes (Gf).—This is a light-colored, shallow, medium-textured soil of the uplands. It occurs on steep slopes where shale and sandstone are near the surface.

The silt loam surface layer ranges from pale brown to dark grayish brown in color and from 4 to 9 inches in thickness. It contains a few sandstone or limestone fragments, 3 to 6 inches in diameter. This layer overlies a lighter colored layer of silt loam that ranges from 5 to 15 inches in thickness and also contains a few stones. The material about 14 to 20 inches from the surface consists of partly decomposed siltstone, shale, sandstone, or dolomitic limestone.

Profile description (along U.S. Highway No. 63; one-fourth mile south of Silver Fork):

- A₁ 0 to 4 inches, pale-brown (10YR 6/3), stony silt loam with a few sandstone or limestone fragments, 3 to 6 inches in diameter; weak, fine, granular structure.
- A₂ 4 to 18 inches, very pale brown (10YR 7/4), coarse silt loam and loam with a few sandstone and shale fragments; weak, fine, granular structure.
- D 18 inches +, partly decomposed siltstone, shale, sandstone, and dolomitic limestone.

Use and suitability.—Because of steep slopes and stoniness, this soil is used mainly for forests. The timber is generally inferior. The low moisture-supplying capacity of this soil limits grass production. (Capability unit VIIIs-6.)

Hatton silt loam, 3 to 7 percent slopes (Ha).—This is a light-colored, medium-textured soil of the uplands. It occurs on the ridgetops and is surrounded by areas of Lindley soils. It is mainly in the northern part of the county.

The silt loam surface layer, about 6 inches thick, is grayish brown to light brownish gray. It overlies a silt loam layer, about 3 inches thick, that is light yellowish brown to very pale brown. The subsoil, beginning at a depth of about 9 inches, is yellowish brown in the upper part and becomes grayer in the lower part; it is mottled with yellowish red to yellowish brown. The underlying material consists of glacial till.

Profile description (SE¼NE¼ sec. 3, T. 51 N., R. 13 W.):

- A₁ 0 to 6 inches, grayish-brown (10YR 5/2), very friable silt loam; weak, thin, platy structure.
- A₂ 6 to 9 inches, light yellowish-brown (10YR 6/4), very friable silt loam; weak, medium, platy structure.
- B₁ 9 to 13 inches, yellowish-brown (10YR 5/4), slightly plastic silty clay loam; moderate, fine, subangular blocky structure.
- B₂₁ 13 to 19 inches, yellowish-brown (10YR 5/4), plastic silty clay mottled with reddish brown (5YR 4/3); moderate, medium, subangular blocky structure.
- B₂₂ 19 to 30 inches, gray (10YR 6/1), plastic clay loam mottled with yellowish brown (10YR 5/6); massive (structureless).
- D 30 to 48 inches +, yellowish-brown (10YR 5/8), plastic clay loam mottled with gray (10YR 6/1) and yellowish red (5YR 4/8); small quartz pebbles are scattered throughout this horizon; massive (structureless).

Use and suitability.—The irregularly shaped fields on the narrow ridges are not well suited to cultivation. Some areas of this soil are forested. Cleared areas are used mainly for pasture, but a few fields are planted to corn and are farmed with the adjacent Lindley soils.



Figure 3.—Landscape of rolling Lindley soils. These soils are used mainly for pasture, but the gentler slopes are commonly used for cultivated crops and many of the steeper slopes are in forest.

The Hatton soil is low in fertility but responds well to lime and fertilizer. Because of the gentle slopes, erosion is not so severe on this soil as on the surrounding Lindley soils. (Capability unit IIIe-6.)

Lindley loam and clay loam, 5 to 8 percent slopes (Ic).—This mapping unit consists of soils that vary in color, texture, and depth. These are the most extensive soils mapped in Boone County.

Normally, the surface soil is dark grayish-brown loam, about 4 to 8 inches thick; it overlies a layer of pale-brown to light yellowish-brown loam, about 3 inches thick. The subsoil is generally yellowish brown in the upper part and is mottled with gray in the lower part. The texture of the subsoil is clay loam, sandy clay loam, sandy clay, or silty clay.

Cultivated fields have a varied color pattern because of different degrees of erosion. The surface layer does not have the mellow or friable consistence that is characteristic of soils with more organic matter. In many places this layer is less than 5 inches thick.

Profile description of Lindley loam (3 miles north of Hallsville):

- A₁ 0 to 4 inches, dark grayish-brown (10YR 4/2), very friable loam; weak, fine, granular structure.
- A₂ 4 to 7 inches, pale-brown (10YR 6/3) to light yellowish-brown (10YR 6/4), very friable loam; weak, thin, platy structure.
- B₁ 7 to 20 inches, yellowish-brown (10YR 5/6), very plastic sandy clay; moderate, fine, subangular blocky structure.
- B₂ 20 to 32 inches, mottled light yellowish-brown (10YR 6/4) and light-gray (10YR 7/2), plastic sandy clay; moderate, coarse, subangular blocky structure.
- B₃ 32 to 42 inches +, mottled light yellowish-brown (10YR 6/4) and light-gray (10YR 7/2), plastic sandy clay; massive (structureless) but breaks to weak, coarse, blocky structure.

Use and suitability.—These soils are moderately rolling, and most areas are cultivated. Corn and small grains are grown, but yields are low unless fertilizer is added. Erosion control practices are needed. (Capability unit IVe-6.)

Lindley loam and clay loam, 9 to 15 percent slopes (Ib).—The soils of this mapping unit vary in color, texture, and depth. They are extensive in Boone County. These

soils are similar to Lindley loam and clay loam, 5 to 8 percent slopes, but their short slopes are dissected more by drainageways and gullies (fig. 3). Eroded spots occur mainly on the upper parts of the slopes.

Use and suitability.—Most areas of these soils have been cleared and are used mainly for pasture. Many of the old pastures are infested with broomsedge, briars, and oak sprouts. Lespedeza, redtop, and bluegrass are the dominant pasture grasses. Fertilization is needed to improve the stand and growth of legumes. (Capability unit VIe-1.)

Lindley loam, 16 to 25 percent slopes (Ic).—Most areas of this soil have not been cultivated; therefore, the color, texture, and depth are more uniform than in cultivated areas of less sloping Lindley soils. This soil has a profile similar to that described for Lindley loam and clay loam, 5 to 8 percent slopes.

Use and suitability.—Most of this soil is forested, mainly with white oak. Trees grow rapidly, and consequently, it is best to keep the areas in woodland for protection against erosion.

The cleared areas are mostly in pasture of low quality. Terracing is not feasible, and plowing would be difficult on the short, steep slopes. Because of limitations in use of tillage implements, it is more difficult to improve the fertility of this soil than that of the less sloping Lindley soils. (Capability unit VIIe-6.)

Mandeville silt loam, 5 to 8 percent slopes (Ma).—This is a light-colored, medium-textured soil that occurs on upland slopes where the bedrock is near the surface.

The surface layer is dark grayish-brown to light brownish-gray silt loam, about 6 inches thick. It overlies a layer of pale-brown silt loam, about 4 inches thick. The subsoil is yellowish-brown silty clay loam in the upper part; this material grades to mottled gray and brownish-yellow silty clay in the lower part. At a depth of about 36 inches, the subsoil is underlain by partly decomposed shale.

Profile description (SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 49 N., R. 13 W.):

- A₁ 0 to 6 inches, dark grayish-brown (10YR 4/2), friable silt loam; light brownish gray (10YR 6/2) when dry; weak, fine, granular structure.
- A₂ 6 to 10 inches, pale-brown (10YR 6/3), very friable silt loam; weak, fine, granular structure.
- B₁ 10 to 14 inches, yellowish-brown (10YR 5/6), slightly plastic silty clay loam; when dry, light yellowish-brown (10YR 6/4) and light brownish-gray (10YR 6/2) coatings on peds; strong, fine, subangular blocky structure.
- B₂₁ 14 to 23 inches, brown (10YR 5/3), plastic silty clay mottled with gray (10YR 5/1) and brownish yellow (10YR 6/8); weak, medium, subangular blocky structure.
- B₂₂ 23 to 36 inches, mottled gray (10YR 5/1) and brownish-yellow (10YR 6/4 to 6/6) plastic silty clay; weak, medium, subangular blocky structure.
- C 36 to 42 inches +, partly decomposed silty shale.

Use and suitability.—Many areas of this soil are in pasture. Corn, small grains, and clover are also grown. The soil is low in fertility and contains a small amount of organic matter, but it is well drained and responds well to fertilizer. (Capability unit IVe-2.)

Mandeville silt loam and silty clay loam, 9 to 16 percent slopes (Mb).—This mapping unit consists of Mandeville soils that vary in color, texture, and depth. Erosion has occurred in a spotted pattern. The A horizons are

thinner and lighter in color than those described in the profile of the more gently sloping Mandeville soil. In places, plowing has mixed the remainder of the A horizons with part of the finer textured subsoil, and as a result, the plow layer is silty clay loam in texture.

Use and suitability.—Most areas of these soils are in pasture of low quality. Some of the steeper slopes are in forest. Corn, small grains, and hay are grown on some of the slopes that are suited to cultivation.

The areas respond well to the application of fertilizer and to other good management practices. Pastures should be fertilized to improve the stand and growth of legumes. (Capability unit VIe-1.)

Marion silt loam, 1 to 3 percent slopes (Mc).—This is a light-colored, medium-textured, nearly level soil. It occurs in upland areas referred to locally as post-oak ridges. It is associated with Hatton and Lindley soils but is more poorly drained.

The gray silt loam surface layer, about 7 inches thick, overlies a layer of light-gray silt loam, about 5 inches thick. The subsoil, which begins at a depth of about 12 inches, is light brownish-gray clay in the upper part and pale-yellow silty clay in the lower part.

Profile description (SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T. 50 N., R. 13 W.):

- A₁ 0 to 7 inches, gray (10YR 5/1), very friable silt loam; weak, platy structure.
- A₂ 7 to 12 inches, light-gray (10YR 6/1), friable to firm silt loam; weak, platy structure to massive (structureless); contains small iron concretions.
- B₂ 12 to 24 inches, light brownish-gray (2.5Y 6/2), firm clay; massive (structureless) in place, but breaks to fine, subangular blocky structure.
- B₃₁ 24 to 30 inches, light-gray (2.5Y 7/2) silty clay mottled with yellow (2.5Y 7/6); coarse, blocky structure.
- B₃₂ 30 to 40 inches +, pale-yellow (2.5Y 7/3) silty clay; yellow and gray streaks; coarse, blocky structure.

Use and suitability.—Corn, small grains, and hay are grown on this soil. After a few years of cultivation, however, the land is generally used for pasture. Lespedeza and redtop are the major forage crops.

This soil is acid and has a dense subsoil that restricts internal drainage. Consequently, the soil is somewhat droughty and unfavorable for deep-rooted crops. Applications of lime and fertilizer are essential for improving yields, but even after such treatment the soil is low in productivity. (Capability unit IIIw-3.)

Menfro silt loam, terrace phase, 1 to 3 percent slopes (Md).—This is a brown, well-drained, deep, nearly level or gently sloping soil. It is not extensive and occurs in small areas, mostly less than 40 acres in size. It is on terraces or benches in the larger valleys within the general soil area known as river-hill land.

The brown, very friable silt loam surface layer is about 14 inches thick. The subsoil is yellowish-brown, friable silty clay loam. Below a depth of 3 to 5 feet, there is silt loam that is yellowish brown with gray streaks and yellow mottling.

Profile description (NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 21, T. 48 N., R. 14 W.):

- A₁ 0 to 14 inches, brown (10YR 4/3), very friable silt loam; weak, fine, granular structure.
- B₁ 14 to 19 inches, yellowish-brown (10YR 5/4), friable silty clay loam; weak, fine, subangular blocky structure.
- B₂₁ 19 to 30 inches, yellowish-brown (10YR 5/4), friable silty clay loam; moderate, medium, subangular blocky structure.

B₂₂ 30 to 40 inches, dark yellowish-brown (10YR 4/4), friable silty clay loam; moderate, coarse, subangular blocky structure.

Use and suitability.—This soil is used mainly for growing corn. Legumes and grasses are also grown. The nearly level relief, favorable physical characteristics, and high fertility make this one of the most suitable soils for intensive farming. (Capability unit IIe-1.)

Menfro silt loam and silty clay loam, 6 to 13 percent slopes (Me).—This mapping unit consists of upland soils that vary in texture and color. Because of tillage and subsequent erosion, the thickness of the remaining surface layer varies. In spots the plow layer has a finer texture and lighter color because some of the subsoil has been mixed with it by tillage. Areas that have not been subject to much erosion have a profile similar to the one described for the terrace phase of Menfro silt loam.

Most areas of these soils have rolling relief. There are some moderately sloping areas with fairly long slopes and some with narrow, rounded ridgetops.

Use and suitability.—Corn, wheat, clover, and alfalfa are the major crops grown. Small acreages are in tobacco, orchards, and berries.

Most of the acreage is cultivated. All the common crops grow well, but yields are lower on eroded spots. The soils are very responsive to applications of nitrogen and phosphate fertilizers. Erosion control is the major problem. Gullies form rapidly in unprotected areas. Terracing is rarely feasible because of the difficulty in disposing of water that collects. Erosion is most effectively controlled by contouring, stripcropping, and the frequent inclusion of grass in the cropping system. (Capability unit IIIe-1.)

Menfro silt loam and silty clay loam, 14 to 19 percent slopes (Mf).—This mapping unit consists of upland soils that vary in texture and color. In some eroded spots, plowing has mixed part of the clayey subsoil with the surface layer, and these spots are lighter in color. In less eroded areas, the profile is similar to the profile described for the terrace phase of Menfro silt loam. At the base of some of the steeper slopes, there is an accumulation of soil material that came from the upper part of the slopes.

Use and suitability.—Many areas of these soils are used for cultivated crops, but much of the acreage is in pasture.

The irregular shape of the fields and the strong slopes make cultivation difficult. Control of erosion is difficult because the slopes are not suitable for terraces or for contour cultivation. These soils are best suited to pasture. Pastures respond well to applications of fertilizer. (Capability unit IVe-1.)

Menfro silt loam and silty clay loam, 20 to 50 percent slopes (Mg).—This mapping unit consists of steep upland soils that vary in texture and color. On many of the slopes, all of the surface soil has been removed. As a result of mass movement of soil, some areas have slopes that resemble escarpments. Landslides have occurred in places where the silty material is less than 10 feet thick over limestone or shale. Runoff rapidly cuts gullies into the soft soil material, and the soil slumps in large blocks. This mapping unit is extensive.

Use and suitability.—Most areas of these soils are in pasture or woodland. They should be kept in perma-



Figure 4.—Field of Mexico silt loam, 1 to 3 percent slopes, on which soybeans are being harvested. Trees in background border small natural draws in prairie area.

nent vegetation. Careful management should be practiced to control erosion. (Capability unit VIe-1.)

Mexico silt loam, 1 to 3 percent slopes (Mh).—This is a moderately dark, medium-textured, nearly level prairie soil that occurs in the uplands. It is an extensive soil and is mainly in the eastern part of the county (fig. 4).

The dark grayish-brown silt loam surface layer, about 7 inches thick, overlies a lighter colored grayish-brown layer of silt loam, about 4 inches thick. The subsoil, which begins at a depth of about 12 inches, is very dark grayish-brown clay in the upper part and yellowish-brown silty clay in the lower part. It is mottled with red, yellowish brown, and gray. Light-gray silty clay occurs at a depth of about 36 inches.

Mexico soils are often called claypan soils. The claypan subsoil retards internal drainage and limits root penetration. Plants may be damaged by lack of moisture as well as by wetness.

Profile description (near pumping plant, 3 miles south of Centralia) :

- A₁ 0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; contains iron concretions.
- A₂ 7 to 11 inches, grayish-brown (10YR 5/2) silt loam; weak, fine, granular structure; contains iron concretions.
- B₁ 11 to 12 inches, brown (10YR 4/3) silty clay loam mottled with light gray and red; moderate, medium, granular structure.
- B₂₁ 12 to 15 inches, very dark grayish-brown (10YR 3/2) clay mottled with red (10R 4/6); moderate, medium, subangular blocky structure that tends toward prismatic.
- B₂₂ 15 to 24 inches, dark grayish-brown (10YR 4/2) clay mottled with yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure that tends toward prismatic.
- B₃ 24 to 36 inches, yellowish-brown (10YR 5/6) silty clay stained with brown and mottled with gray; weak, medium, subangular blocky structure.
- C 36 inches +, light-gray (10YR 7/1) silty clay; massive (structureless).

Use and suitability.—Corn, soybeans, wheat, oats, clover, and bluegrass are grown extensively on this soil. The soil is medium in productivity and responds well to lime and fertilizer. Crops that are not limed and fertilized are likely to be damaged by lack of moisture. Their roots will not have the vigor to penetrate the subsoil in sufficient numbers to supply needed moisture.

The prevention of erosion is important on this soil be-

cause the subsoil has low fertility. When the subsoil becomes mixed with the plow layer because of erosion, crop yields are reduced. Lime and fertilizer are especially effective in increasing the stands and yields of legumes and grass. (Capability unit IIIe-5.)

Mexico silt loam, 2 to 4 percent slopes, moderately and severely eroded (Mk).—As a result of erosion, this gently sloping soil varies in texture and color. The plow layer of the moderately eroded spots is a mixture of the subsoil and what remains of the original surface layer. The plow layer of the severely eroded spots, however, is mainly subsoil material that is lighter in color and finer in texture than elsewhere and is very difficult to plow. In some spots the soil is less eroded and the profile is similar to the profile described for Mexico silt loam, 1 to 3 percent slopes. This mapping unit is extensive.

Use and suitability.—All of the common crops in the county are grown on this soil. The areas have been cultivated intensively in the past and have been subject to excessive loss of soil. Lime and fertilizer must be applied to obtain higher yields. An increase in organic matter is needed to improve tilth of the eroded spots. This can be done by using manure and green-manure crops. Surface runoff should be controlled. Drainage-ways should be properly designed and grassed for the safe removal of excess water. A vegetative cover should be maintained as much of the time as possible. (Capability unit IVE-5.)

Mexico silt loam, light-gray variant, 1 to 3 percent slopes (Ml).—This soil occurs on ridges that extend from the level prairie into the hills. At one time it was covered with prairie grasses and was moderately dark colored. Later, it became covered with trees, and, as a result, the color of the soil gradually changed. Except for its slightly lighter colors, this soil resembles Mexico silt loam, 1 to 3 percent slopes. It is fairly extensive.

The grayish-brown silt loam surface layer is about 9 inches thick; it is mottled with yellowish brown and gray in the lower 2 inches. The clayey subsoil is grayish brown to dark gray in the upper part and light gray in the lower part. It is mottled throughout with yellowish brown. Gray glacial till is at a depth of about 56 inches.

Profile description (SE $\frac{1}{2}$ sec. 9, T. 49 N., R. 12 W.; three-fourths of a mile southwest of Browns Station) :

- A₁ 0 to 7 inches, grayish-brown (10YR 5/2), very friable silt loam; light brownish gray (10YR 6/2) when dry; weak, fine, granular structure.
- A₂ 7 to 9 inches, grayish-brown (10YR 5/2), very friable silt loam mottled with yellowish brown (10YR 5/6), and gray (10YR 5/1); weak, fine, granular structure.
- B₁ 9 to 12 inches, grayish-brown (10YR 5/2), friable silty clay mottled with yellowish brown (10YR 5/6) and gray (10YR 5/1); moderate, medium, subangular blocky structure.
- B₂ 12 to 20 inches, mottled dark-gray (10YR 4/1) and yellowish-brown (10YR 5/4), firm clay; weak, medium, subangular blocky structure.
- B₃₁ 20 to 30 inches, light olive-gray (5Y 6/2), friable silty clay mottled with dark yellowish brown (10YR 4/4); weak, very fine, subangular blocky structure.
- B₃₂ 30 to 56 inches, light-gray (10YR 6/1), friable silty clay loam mottled with yellowish brown (10YR 5/6); weak, very fine, subangular blocky structure.
- D 56 inches +, gray (10YR 5/1) glacial till; massive (structureless); some iron and manganese concretions occur throughout the profile.

Use and suitability.—All of the common crops in the county are grown on this soil. Because it contains less organic matter, the soil does not retain as much moisture as Mexico silt loam, 1 to 3 percent slopes. Also, under comparable management, it produces somewhat lower yields. The soil can be made more productive by using barnyard manure to increase organic matter, by growing green-manure crops, and by frequently including grasses in the cropping system. (Capability unit IIIe-5.)

Moniteau silt loam (Mm).—This is a light-colored, medium-textured soil that is on high bottoms along the larger creeks.

The surface layer, to a depth of about 13 inches, is light brownish-gray silt loam. It has platy structure beneath the granular 6- to 8-inch plow layer. The underlying material, to a depth of about 30 inches or more, is mottled gray and light-gray silty clay loam. Many iron and manganese concretions (buckshot) occur on the surface and throughout the profile.

Profile description (SW $\frac{1}{4}$ sec. 25, T. 49 N., R. 14 W.):

- A₁ 0 to 8 inches, light brownish-gray (10YR 6/2) silt loam; light gray (10YR 7/1) when dry; weak, fine, granular structure.
- A₂ 8 to 13 inches, light brownish-gray (10YR 6/2), friable silt loam; light gray (10YR 7/1) when dry; weak, thin, platy structure.
- B₁ 13 to 30 inches, gray (10YR 5/1) silty clay loam; light gray (10YR 7/1) when dry; mottled with yellowish brown (10YR 5/4); weak, fine and medium, subangular blocky structure with some evidence of platy structure in the upper part.
- B₂ 30 inches +, mottled gray (10YR 5/1) and light-gray (10YR 6/1) silty clay loam; moderate, fine and medium, subangular blocky structure; many iron and manganese concretions (buckshot) occur in this layer and throughout the profile.

Use and suitability.—This soil is best used for pasture. Grain crops, particularly corn, produce low yields, especially in dry or in wet years. Redtop and timothy grow well. Crop yields can be increased if lime and fertilizer are applied, although this soil does not respond so well to these amendments as many of the other soils.

Important measures for improving crop yields are surface drainage and diversion of runoff water from the adjacent slopes. Often, the soil is wet only in spring. (Capability unit IIIw-1.)

Onawa silty clay loam (Oa).—This is a dark-colored, moderately fine textured soil that occurs on the flood plains of the Missouri River. It is sometimes called gumbo, because of its clayey surface soil. It is subject to overflow and may receive deposits of silt or sand during each flood.

In most places the surface layer is very dark brown to black silty clay loam, about 12 inches thick. The thickness of the surface layer varies from about 12 to 48 inches. The underlying material is generally more sandy, but in places it consists of alternate layers of sandy and clayey material.

Profile description (one-fourth mile north of McBaine):

- 1. 0 to 12 inches, very dark brown (10YR 2/2) silty clay loam; dark gray (10YR 4/1) when dry; granular structure.
- 2. 12 to 24 inches, nearly black (10YR 2/2 to 2/1) silty clay.
- 3. 24 to 36 inches, dark-brown (10YR 3/3) clay loam; in many places this horizon consists of brown sandy loam; this sandy layer occurs anywhere between a depth of 12 and 48 inches.

Use and suitability.—Corn is the major crop. Alfalfa usually grows well on this soil. In favorable seasons, yields of all crops are high. In wet seasons, yields may be greatly reduced because of poor surface drainage.

This soil is high in fertility because it receives fresh deposits of material rich in minerals during the occasional floods. The content of organic matter is also high. Except for nitrogen, fertilizer is not ordinarily needed for the production of high yields. (Capability unit IIw-1.)

Onawa silty clay (Ob).—This soil has a more clayey and generally thicker surface layer than Onawa silty clay loam. It is very cloddy if worked when wet, and on drying it shrinks and cracks. It is of minor extent.

The very dark gray silty clay surface layer is about 18 inches thick. In places it overlies a layer of very dark grayish-brown silty clay loam that extends to a depth of about 30 inches. In many places the silty clay loam is underlain by a grayish-brown layer of fine sandy loam. As in Onawa silty clay loam, the thickness and texture of the layers of this soil vary.

Profile description (1 mile southwest of McBaine):

- 1. 0 to 18 inches, very dark gray (10YR 3/1), very plastic silty clay; strong, medium, granular structure.
- 2. 18 to 32 inches, very dark grayish-brown (10YR 3/2), plastic silty clay loam; massive (structureless).
- 3. 32 to 42 inches, grayish-brown (10YR 5/2), nearly loose, calcareous fine sandy loam; single grain (structureless).

Use and suitability.—This soil is used mostly for corn. All of the common crops of the county grow well because of the high fertility. The soil is difficult to till because of its clayey texture. It is subject to flooding. (Capability unit IIw-1.)

Pershing silt loam, 2 to 4 percent slopes (Pa).—This is a moderately dark, medium-textured, gently sloping soil. It is generally on long, gentle slopes in the uplands. It resembles Mexico silt loams, except that it is slightly darker and contains less clay in the subsoil. Originally, prairie grasses covered this soil. Later, trees invaded areas of the soil and influenced its development.

The very dark grayish-brown silt loam surface layer is about 12 inches thick. It overlies a layer of grayish-brown silt loam that is about 3 inches thick. The upper subsoil, which begins at a depth of about 15 inches, is dark grayish-brown silty clay loam, about 5 inches thick, that overlies a heavier layer of dark-gray, plastic silty clay. The lower subsoil, beginning at a depth of about 28 inches, is gray silty clay loam. The subsoil is mottled with yellowish brown, yellowish red, and gray.

Profile description (SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 36, T. 48 N., R. 13 W.):

- A₁ 0 to 12 inches, very dark grayish-brown (10YR 3/2), friable silt loam; grayish brown (10YR 5/2) when dry; moderate, medium, granular structure.
- A₂ 12 to 15 inches, dark grayish-brown (10YR 4/2), friable silt loam; grayish brown (10YR 5/2) with light brownish-gray (10YR 6/2) coatings when dry; weak, medium, granular structure.
- B₁ 15 to 20 inches, dark grayish-brown (10YR 4/2), slightly plastic silty clay loam with coatings of light brownish gray (10YR 6/2); moderate, fine, subangular blocky structure.
- B₂ 20 to 28 inches, dark-gray (10YR 4/1), plastic silty clay mottled with yellowish brown (10YR 5/6) and yellowish red (5YR 5/6); strong, medium, subangular blocky structure; some small iron and manganese concretions.

B₃ 28 to 41 inches, gray (10YR 6/1), slightly plastic silty clay loam mottled with yellowish brown (10YR 5/6) and gray (10YR 5/1); weak, medium, subangular blocky structure.

Use and suitability.—Corn, soybeans, small grains, legumes, and grasses grow well on this soil. Management requirements are similar to those for the Mexico silt loams, but crop yields are higher.

All of the soil is farmed intensively. Erosion is a hazard, but the soil is well suited to terracing and contour cultivation. Drainageways should be properly designed and grassed to remove excess water safely. (Capability unit IIIe-5.)

Putnam silt loam, 0 to 2 percent slopes (Pb).—This is a moderately dark, medium-textured, nearly level soil. It occurs in the uplands, mainly in the northeastern part of the county, and is of moderate extent. It is called a claypan soil because of its clayey subsoil. Internal drainage is very slow. In wet periods the subsurface layer is saturated with water; as a result, this layer has been leached and is gray in color (fig. 5). Tile drainage is not practical because of the relatively impermeable subsoil. It is very difficult for enough plant roots to penetrate the subsoil to obtain the moisture needed during dry periods. As a result, crop damage is caused more frequently by lack of moisture than by excessive moisture.

The dark grayish-brown silt loam surface layer is about 9 inches thick. It overlies a gray silt loam subsurface layer that is about 7 inches thick. The very plastic clay subsoil is mottled gray and yellowish red in the upper part and is dark grayish brown mottled with yellowish brown in the lower part. At a depth of about 36 inches, there is gray silty clay mottled with yellowish brown.

Profile description (NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 51 N., R. 12 W.):

- A₁ 0 to 9 inches, dark grayish-brown (10YR 4/2), very friable silt loam; weak, fine, granular structure.
- A₂ 9 to 16 inches, light brownish-gray (10YR 6/2), very friable silt loam; weak, fine, granular structure.
- B₂₁ 16 to 18 inches, mottled gray (10YR 5/1) and yellowish-red (5YR 5/6), very plastic clay; weak, fine, subangular blocky structure.
- B₂₂ 18 to 36 inches, dark grayish-brown (10YR 4/2), very plastic clay; mottled with yellowish brown (10YR 5/6); weak, fine, subangular blocky structure.
- C 36 to 42 inches +, gray (10YR 6/1), plastic silty clay; mottled with yellowish brown (10YR 5/6); massive (structureless).

Use and suitability.—More of this soil is in cultivated crops than any other soil of the uplands, and it is one of the most valuable soils of the uplands in the county. Corn, soybeans, wheat, and oats are the important crops. Clover and alfalfa can be grown if the soil is limed and fertilized in amounts determined by soil tests. Liming and fertilizing will also increase the vigor of plant roots and cause more of them to penetrate the dense clay subsoil.

During seasons that are either too wet or too dry, yields of crops decrease markedly. Spring planting of crops is sometimes delayed in level areas that are not well drained. As a result, there has been an increase in the acreage of soybeans, which can be planted later than corn and still have time to mature. (Capability unit IIIw-3.)

Raccoon silt loam, 1 to 3 percent slopes (Rc).—This is a light-colored, medium-textured soil on the nearly level



Figure 5.—Profile of Putnam silt loam, 0 to 2 percent slopes. Distinct horizons are characteristic of this soil.

terraces in the larger creek valleys. The terraces are normally 10 to 15 feet higher than the adjacent bottom lands. This soil has developed under poor drainage and is known locally as crayfish land.

The plow layer, about 7 inches thick, is a grayish-brown to light brownish-gray silt loam, and it overlies a light-gray to white silt loam layer that is about 11 or 12 inches thick. The subsoil begins at a depth of about 18 inches and normally is grayish-brown silty clay mottled with slightly darker colors. At a depth of about 42 inches, there is light brownish-gray silty clay loam mottled with grayish brown.

Profile description (SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 47 N., R. 13 W.):

- A₁ 0 to 7 inches, grayish-brown (10YR 5/2), very friable silt loam; light brownish gray (10YR 6/2) when dry; weak, fine, granular structure; contains scattered iron and manganese concretions.
- A₂ 7 to 18 inches, light-gray (10YR 7/2), very friable silt loam; white (10YR 8/2) when dry; weak, fine, granular structure; this horizon is vesicular and contains many iron and manganese concretions.
- B₂ 18 to 42 inches, grayish-brown (10YR 5/2), plastic silty clay; mottled with dark grayish brown (10YR 4/2); weak, medium, subangular blocky structure; contains scattered iron and manganese concretions.
- C 42 to 50 inches +, light brownish-gray (10YR 6/2), slightly plastic silty clay loam mottled with grayish brown; massive (structureless); contains many iron and manganese concretions.

Use and suitability.—Because of low fertility and poor drainage, this soil is not well suited to corn. Most of it is used for small grains and pasture. Lespedeza and redbud are the main forage crops.

This soil is highly leached and low in organic matter. Lime is a primary requirement. Diversion ditches, to intercept water from the hills, and small field ditches are used to improve surface drainage. (Capability unit IIIw-3.)

Ray silt loam (Rb).—This is a light-colored, nearly level soil. It consists of silty material that has eroded from the river bluffs. This material has been deposited in the creek bottom lands and at points where the small streams enter the flood plain of the Missouri River. Locally, this soil is known as made land.

The brown to pale-brown silt loam surface layer is uniform to a depth that ranges from 12 to 60 inches. This material is underlain by an older, darker bottom-land soil that ranges in texture from silt loam to clay.

Profile description:

1. 0 to 36 inches, brown (10YR 5/3), very friable, coarse silt loam; pale brown (10YR 6/3) when dry; weak, fine, granular structure; soil material ranges in thickness from 12 to 60 inches.
2. 36 inches +, darker colored and finer textured material than that in upper layer; in some places the texture is silt loam.

Use and suitability.—This deep, well-drained soil is very productive and is valued highly for corn and soybeans. It is especially well suited to truck crops. Alfalfa and clover grow well without special soil treatment. Bottom lands that are too narrow for cultivation provide excellent pasture. Lack of nitrogen is usually the factor limiting corn yields. When nitrogen is applied, yields of more than 100 bushels per acre are common. (Capability unit I-1.)

Riverwash (Rc).—This is a miscellaneous land type. It consists of sandbars and other shifting soil materials along the channel of the Missouri River. In some places the sandy material contains lenses of clay, and in others the surface layer consists of clay.

Use and suitability.—This land type is not cultivated. It is subject to frequent flooding. Cottonwood and willow are the dominant trees. The areas provide cover for wildlife. (Capability unit VIIIs-1.)

Salix loam (Sc).—This is a dark-colored, medium-textured soil on high bottom lands along the Missouri River. It occurs in an area near McBaine. The deep soil has good granular structure, is high in fertility, and has a high content of organic matter. It is well drained and is rarely flooded.

The very dark brown, friable loam surface layer is about 27 inches thick. It overlies a layer of dark-brown clay loam that is about 10 inches thick. The underlying material, beginning at a depth of about 36 inches, is dark-brown sandy clay loam. In the northern part of the area of this soil, there are spots where the surface layer is clay loam or sandy clay loam.

Profile description (SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 2, T. 47 N., R. 14 W.):

1. 0 to 27 inches, very dark brown (10YR 2/2), friable loam; strong, medium, granular structure.
2. 27 to 36 inches, dark-brown (10YR 4/3), slightly plastic clay loam; peds are coated with very dark gray (10YR 3/1); strong, coarse, subangular blocky structure.
3. 36 to 50 inches +, dark-brown (10YR 4/3), friable sandy clay loam; massive (structureless).

Use and suitability.—All of this soil is farmed intensively, and good yields are obtained consistently. Corn, wheat, soybeans, alfalfa, and clover are grown. The soil is well suited to vegetable crops, and, because of its location, it can easily be irrigated. Yields of crops are increased by growing clover as a green-manure crop and by the addition of nitrogen fertilizer. (Capability unit I-1.)

Sapp soils, 3 to 5 percent slopes (Sb).—This mapping unit consists of soils that vary in texture, color, and thickness of the surface layer, because of erosion. In some places most of the original silt loam surface layer remains. In many places, however, the plow layer con-

sists mainly of clay material of the original subsoil. Sapp soils occur in transitional areas between the Mexico soils of the prairie and the Lindley soils of timber areas. Sapp soils may therefore have some of the characteristics of both Mexico and Lindley soils.

Relatively uneroded spots have a grayish-brown silt loam surface layer, about 5 inches thick, that overlies a layer of light brownish-gray silt loam, about 3 inches thick. The dark grayish-brown clay subsoil begins abruptly at a depth of about 7 or 8 inches and is about 12 inches thick. Mottled gray and yellowish-brown clay or sandy clay occurs below a depth of about 20 inches.

Profile description of Sapp silt loam (E $\frac{1}{2}$ sec. 6, T. 50 N., R. 12 W.; 4 miles northwest of Hallsville):

- A₁ 0 to 5 inches, grayish-brown (10YR 5/2) to light brownish-gray (10YR 6/2) silt loam; some sand grains observable; weak, fine, granular structure.
- A₂ 5 to 8 inches, light brownish-gray (10YR 6/2) to light gray (10YR 7/1) silt loam; some sand grains observable; weak, thin, platy structure; contains many iron concretions.
- B₂₁ 8 to 11 inches, mottled dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/4), very plastic clay; some sand grains observable; moderate, medium, subangular blocky structure; contains some iron concretions.
- B₂₂ 11 to 20 inches, mottled dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/4), plastic clay; some sand grains observable; weak, medium, subangular blocky structure.
- C₁ 20 to 30 inches, mottled light brownish-gray (10YR 6/2) and light yellowish-brown (10YR 6/4) sandy clay; massive (structureless).
- C₂ 30 inches +, mottled gray (10YR 5/1) and light yellowish-brown (10YR 6/4), plastic sandy clay; massive (structureless).

Use and suitability.—Though gently sloping, most areas of these soils have been subject to severe erosion. As a result, they are dissected by gullies and are unsuitable for cultivation. The soils are low in fertility. The plant cover consists mainly of scrub oak, briars, and wild grasses. Use of the soils is limited mainly to pasture; however, some areas are used for limited cropping. Red-top and lespedeza are the most suitable forage plants. (Capability unit IVE-5.)

Sarpy sand (Sc).—This is a light-colored, coarse-textured soil. It consists of sand deposited along the Missouri River by strong currents during periods of overflow.

The sand is lighter in color and somewhat coarser than that of Sarpy loamy fine sand. When first deposited, it may be nearly white, but it becomes darker within a few years. The sand is generally loose to a depth of 3 or more feet and has little, if any, stratification. The relief is characterized by low ridges and shallow depressions, or swales, that roughly parallel the river channel.

Use and suitability.—Much of this soil is used for corn. The fertility of the soil is high, but the moisture-supplying capacity is very low because of the extremely sandy texture. Crop yields are low in dry seasons. Sweetclover or cover crops, grown for 1 or more years, will improve the freshly deposited sandy material. This will cause the incoherent sand to develop weak aggregates. Most uncultivated areas are covered by willow and cottonwood trees. (Capability unit IVs-4.)

Sarpy loamy fine sand (Sd).—This is a light-colored, coarse-textured, nearly level soil of the bottom lands. It is fertile because the sandy material contains many minerals other than quartz. It has a low moisture-holding capacity, and plants are damaged during prolonged dry periods. In normal seasons, however, plant roots penetrate to greater depths in this soil than in most of the finer textured soils.

The grayish-brown loamy fine sand surface layer generally has weak, crumb structure to a depth of about 18 inches. Below this depth the soil is generally structureless, but in places it contains lenses of fine sandy loam.

Profile description (1 mile south of McBaine):

1. 0 to 18 inches, grayish-brown (10YR 5/2), loose loamy fine sand; light brownish gray (10YR 6/2) when dry; weak, fine, crumb structure.
2. 18 to 36 inches +, grayish-brown (10YR 5/2) loamy fine sand with lenses of very dark grayish-brown fine sandy loam; single grain (structureless).

Use and suitability.—Corn is the main crop on this soil. Small grains and meadow crops are also grown. Yields are generally lower than on Sarpy very fine sandy loam. The soil is well suited to melons and other truck crops because of its high fertility and good drainage.

This soil is subject to wind erosion. Sweetclover is frequently sown in wheat to protect the soil from blowing after the grain is removed and to provide organic matter. Areas of this soil are subject to overflow. (Capability unit IIIs-1.)

Sarpy very fine sandy loam (Se).—This is a moderately dark to light colored, nearly level, sandy soil of the bottom lands. It is less coarse textured and has higher fertility and better moisture-supplying capacity than the other Sarpy soils. Sarpy very fine sandy loam includes a few small areas of Sarpy loamy fine sand because of the indistinct boundaries between these two soils.

The surface layer, to a depth of about 15 inches, is dark grayish-brown very fine sandy loam. Below this is dark-brown very fine sandy loam that becomes brown and slightly coarser at a depth of about 22 inches.

Profile description (2 miles south of McBaine):

1. 0 to 15 inches, dark grayish-brown (10YR 4/2), very friable very fine sandy loam; grayish brown (10YR 5/2) when dry; weak, fine, granular structure.
2. 15 to 22 inches, dark-brown (10YR 4/3), very friable very fine sandy loam; weak, fine, granular structure.
3. 22 to 42 inches +, brown (10YR 5/3), very friable fine sandy loam; single grain (structureless).

Use and suitability.—High fertility, great depth, and ease of tillage make this soil valuable for corn and wheat. High yields of these crops, as well as of soybeans, clover, and alfalfa, are obtained. Except for nitrogen, fertilizer is rarely added. The soil is subject to occasional flooding from the Missouri River. (Capability unit I-1.)

Seymour silt loam, 2 to 4 percent slopes (Ss).—This is a dark-colored, medium-textured prairie soil. It occurs in the uplands near Woodlandville and extends south to U.S. Highway No. 40. Locally, it is known as Woodlandville prairie. This soil is similar to the dark prairie soils that occur in the northwestern part of the State. It is darker than the Mexico and Putnam soils and has less clay in the subsoil.

The very dark grayish-brown silt loam surface layer is about 11 inches thick. It overlies a layer of dark grayish-brown silt loam, about 5 inches thick. The subsoil, which begins at a depth of about 16 inches, has a silty clay loam texture in the upper part and a silty clay texture in the lower part. It is mottled with gray and brown. Structureless gray silty clay occurs below a depth of 36 inches.

Profile description (sec. 21, T. 49 N., R. 14 W.; one-half mile west of school):

- A₁ 0 to 11 inches, very dark grayish-brown (10YR 3/2), very friable silt loam; strong, medium, granular structure.
- A₃ 11 to 16 inches, dark grayish-brown (10YR 4/2), very friable silt loam; moderate, fine, granular structure.
- B₁ 16 to 20 inches, mottled yellowish-brown (10YR 5/4) and dark-gray (10YR 4/1), moderately plastic silty clay loam; strong, fine, subangular blocky structure.
- B₂ 20 to 36 inches, mottled gray (10YR 5/1) and brown (10YR 5/3), very plastic silty clay; moderate, fine, subangular blocky structure.
- C 36 inches +, gray (10YR 5/1), very plastic silty clay; massive (structureless).

Use and suitability.—Corn is the major crop on this soil, but a considerable acreage of wheat and hay is grown. This is one of the most productive soils in the county, but lime is needed for the growth of clover or alfalfa. Average yield of crops are higher than on other soils of the uplands. The soil is especially well suited to bluegrass. Erosion is a hazard, but the gentle slopes are suitable for terracing. (Capability unit IIIe-5.)

Seymour silt loam, 3 to 7 percent slopes, moderately eroded (Sg).—This soil has a thinner surface soil and is on more rolling relief than the Seymour soil just described. In most places less than 8 inches of the original surface soil remains. In some spots the plow layer is a mixture of the remaining surface soil and part of the subsoil. This mixture is generally lighter in color and finer in texture than the plow layer in less eroded areas. The horizons below the plow layer are similar to those of the profile described for Seymour silt loam, 2 to 4 percent slopes.

Use and suitability.—More of this soil is used for small grains and grasses than of Seymour silt loam, 2 to 4 percent slopes. Yields are somewhat lower, however, and more careful management is required for the control of erosion. (Capability unit IIIe-5.)

Sharon silt loam (Sh).—This is a medium-textured, well-drained, brown soil that occurs on bottom lands along the smaller streams. It is subject to occasional flash flooding. It is covered for only short periods, however, and crops are not often extensively damaged.

The surface layer is generally dark-brown to dark grayish-brown silt loam, about 16 inches deep. In some included areas along streambanks and in narrow bottoms, the texture ranges from loam to fine sandy loam. Below a depth of 16 inches, the soil material is grayish brown, and in many places it is of sandy loam texture.

Profile description (NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 49 N., R. 13 W.):

1. 0 to 16 inches, dark-brown (10YR 4/3) to dark grayish-brown (10YR 4/2), friable silt loam; weak, fine, granular structure.
2. 16 to 42 inches +, grayish-brown (10YR 5/2), friable silt loam; weak, fine, granular structure.

Use and suitability.—Because of favorable depth, high fertility, good tilth, and good drainage, this soil is very desirable for corn. Corn is often grown continuously because the adjacent uplands are not suitable for cultivation. Other crops, including clover, alfalfa, and grass, grow equally well. The addition of organic matter by use of green-manure crops is highly desirable on areas where cultivated crops are grown intensively. Some of the narrow bottom lands are not wide enough for easy cultivation and are used for pasture. (Capability unit I-1.)

Sharon silt loam, gravel-substratum variant (Sk).—This soil has a surface layer that is similar in color and texture to the Sharon soil just described. In most places gravel occurs in thick layers below a depth of about 30 inches. In some places, however, it occurs in the form of lenses or bands at any depth in the profile. Gravel is a hindrance, but there is rarely enough to prevent cultivation. This soil generally occurs in areas where the adjacent soils of the uplands are stony.

Use and suitability.—Most of this soil is used for pasture. Bluegrass thrives, except on extremely stony, droughty areas. Some corn is grown, but yields are lower than on stone-free areas of Sharon silt loam. Many of the valleys where this soil occurs are too narrow for cultivation. (Capability unit IIIs-1.)

Snead silty clay, 7 to 12 percent slopes (Sl).—This is a dark-colored, fine-textured, shallow soil. It occurs in small upland areas on steep slopes where limestone and shale are near the surface. It is minor in extent and is mainly in the drainage area of Grindstone and Hinkson Creeks.

The surface layer is very dark brown to black silty clay, about 8 inches thick, that grades to dark-gray or olive-brown silty clay. Partly weathered limestone and shale generally occur below a depth of about 20 inches. The thickness of the soil over bedrock ranges from about 2 to 24 inches, however. The soil is slightly weathered and is calcareous or neutral in reaction.

Profile description (sec. 20, T. 50 N., R. 12 W.):

- A₁ 0 to 8 inches, very dark brown (10YR 2/2) to black (10YR 2/1) silty clay; strong, coarse, granular structure.
- A-C 8 to 20 inches, dark-gray (10YR 4/1) and olive-brown (2.5Y 4/4) silty clay; weak, medium, subangular blocky structure; a few stones in the lower part.
- C 20 inches +, fragments of limestone bedrock and partly decomposed clay shale.

Use and suitability.—Practically all of this soil is used for pasture. Bluegrass grows well without soil treatment. The heavy texture and strong slopes of this soil make cultivation difficult. (Capability unit IVe-2.)

Snead stony clay loam, 11 to 30 percent slopes (Sm).—This soil is similar to the Snead soil just described, but the surface layer contains stones. Limestone and shale bedrock occur within a depth of 24 inches. The soil varies in color and content of stones, according to the kind of parent rock. In areas underlain by limestone, the dark surface soil may rest abruptly on bedrock. In areas underlain predominantly by shale, the color of the soil may be yellowish brown.

Use and suitability.—Most of this soil is in forests of maple, elm, walnut, and oak. Cleared areas are used

for pasture. Bluegrass usually grows well, except on very shallow, dry sites. This soil is not suited to cultivation. (Capability unit VIIs-6.)

Steep stony land, 15 to 50 percent slopes (Sn).—This miscellaneous land type includes stony and rocky areas along the larger creeks and the Missouri River. It is extensive and occurs mainly within areas of Menfro and Union soils.

In places the surface soil material has developed from loess, and in others it is residuum from limestone. It ranges from a few inches to several feet thick over bedrock. Large fragments of chert cover the surface in places.

Profile description (NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 46 N., R. 11 W.):

- A₁ 0 to 3 inches, dark grayish-brown (10YR 4/2), very friable, cherty silt loam; weak, fine, granular structure.
- A₂ 3 to 10 inches, brown (10YR 5/3), very cherty silt loam; weak, fine, granular structure.
- C 10 to 42 inches, yellowish-red (5YR 5/6), cherty silty clay loam; massive (structureless).

Use and suitability.—In most areas of this land type, the mantle of soil is thick enough to have a good cover of forest. Oak, walnut, maple, ash, and other trees are abundant. Where the soil mantle is thin and in glady spots, cedar and other trees suited to droughty sites abound. This land type has little value for pasture, and none of it is suitable for cultivation. (Capability unit VIIs-6.)

Stet silt loam (So).—This is a deep, dark-colored, medium-textured soil of the bottom lands. It has developed in materials eroded from soils that have been influenced by limestone bedrock. It is of minor extent.

The black, friable silt loam surface layer extends to a depth of about 12 inches. It overlies a layer of black silty clay loam that is about 12 inches thick. Very dark brown, plastic clay is at a depth of about 24 inches. In places it contains a few scattered fragments of chert and some fine sand.

Profile description (SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 49 N., R. 12 W.):

- 1. 0 to 12 inches, black (10YR 2/1), friable silt loam; strong, medium, granular structure.
- 2. 12 to 24 inches, black (10YR 2/1), plastic silty clay loam; weak, medium, subangular blocky structure.
- 3. 24 to 42 inches +, very dark brown (10YR 2/2), plastic silty clay; massive (structureless); contains a few scattered fragments of chert and some fine sand.

Use and suitability.—Where drainage is adequate, this soil is excellent for hay and pasture. All of the common crops grow well. Drainage is provided by open ditches and by diversion channels at the base of the adjacent uplands. Some areas of this soil are subject to overflow; more areas, however, are affected by seepage from the uplands. (Capability unit IIIw-1.)

Strip mines (Sp).—The areas of this miscellaneous land type have been mined for coal. They range from 10 to about 40 acres in size. Most Strip mines occur as isolated tracts east of Harrisburg, near Hinton, and north-east of Columbia. Although only about 600 acres are occupied by Strip mines, a much larger acreage is made unsuitable for cultivation because of these mines. Excavations to the beds of coal range from 10 to 30 feet in depth.

Use and suitability.—All of the stripped land and the adjacent areas are used primarily as habitats for wildlife. Stripped material composed of shale requires many years of leaching and weathering before it will support vegetation. Much of this material is glacial till, however, which weathers more rapidly to form soil. Such soil supports a sparse growth of sweetclover, weeds, cottonwood trees, wild cherry trees, and other vegetation. (Capability unit VIIIa-1.)

Union silt loam, 3 to 8 percent slopes (Ua).—This is a light-colored, medium-textured soil. It occurs on upland slopes that border the valleys of creeks. Limestone is near the surface, and the soil has formed in limestone residuum. A few ledges of bedrock outcrop at the surface, but generally the mantle of soil material is several feet thick. The thicker material occurs on the more gentle slopes and on the lower parts of stronger slopes.

The grayish-brown silt loam surface layer is about 5 inches thick. It overlies a layer of yellowish-brown silt loam, about 3 inches thick. The upper layer of subsoil is yellowish-brown silty clay loam. It overlies dark-brown silty clay that extends to a depth of about 20 inches. The lower layer of subsoil is yellowish-red silty clay loam. It is compact and weakly cemented and, as a result, is somewhat brittle when dry. This layer, which is about 15 inches thick, is called a fragipan. It is almost impermeable to moisture and to penetration by roots. At a depth below about 36 inches, there is mottled yellowish-red and gray silty clay loam that is slightly compact and contains fragments of chert.

Profile description (SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, T. 49 N., R. 13 W.):

- A₁ 0 to 5 inches, dark grayish-brown (10YR 4/2), very friable silt loam; grayish brown (10YR 5/2) when dry; weak, fine, granular structure.
- A₂ 5 to 8 inches, yellowish-brown (10YR 5/4), very friable silt loam; light yellowish brown (10YR 6/4) when dry; weak, fine, granular structure.
- B₁ 8 to 11 inches, yellowish-brown (10YR 5/4), slightly plastic silty clay loam; weak, medium, subangular blocky structure.
- B₂₁ 11 to 20 inches, dark-brown (7.5YR 4/4), plastic silty clay; moderate, medium, subangular blocky structure.
- B_{3m} 20 to 36 inches, yellowish-red (5YR 4/6) silty clay loam mottled with gray (10YR 5/1); massive (structureless) to weak, medium, subangular blocky structure.
- C 36 to 42 inches +, mottled yellowish-red (5YR 4/6) and gray (10YR 5/1), cherty silty clay loam; massive (structureless); slightly compact.

Use and suitability.—Much of this soil is in pasture. Corn is grown, but yields are low without soil treatment. When enough fertilizer is used and when a crop rotation that includes grass is followed, crop yields equal those obtained on prairie land.

This soil has less moisture-supplying capacity and contains less organic matter than some of the deeper, more permeable soils of the uplands; therefore, crops may be damaged in dry periods. Management practices that control erosion should be used on this soil. (Capability unit IIIe-6.)

Union silt loam and silty clay loam, 9 to 16 percent slopes (Ub).—This mapping unit consists of soils that vary in color, texture, and thickness of the surface layer. The variations are mainly the result of erosion. In many

places the plow layer is a mixture of the A₁ and A₂ horizons, has a lighter color than that of less eroded spots, and has an abrupt boundary with the subsoil. In other places the plow layer consists mainly of subsoil material and is silty clay loam. Spots that are relatively uneroded have a profile similar to that described for Union silt loam, 3 to 8 percent slopes.

Use and suitability.—Most areas of these soils are in pasture. Plowing for pasture renovation is usually possible, but the growing of cultivated crops is not advisable, because of the hazard of erosion. Terraces are not practical. Some areas are still in woodland that consists of white oak, walnut, and other desirable trees. (Capability unit VIe-1.)

Wabash silty clay loam (Wo).—This is a dark-colored, moderately fine textured soil of the bottom lands. It is very inextensive and occurs on the flood plain of the Missouri River.

The very dark gray silty clay loam surface layer is about 12 inches thick. From a depth of about 12 to 28 inches, there is plastic silty clay. Below a depth of about 28 inches, there is dark-gray, very plastic clay.

Profile description (one-half mile north of McBaine):

- 1. 0 to 12 inches, very dark gray (10YR 3/1), very plastic silty clay loam; moderate, coarse, granular structure.
- 2. 12 to 28 inches, very dark gray (10YR 3/1), very plastic silty clay; moderate, medium, subangular blocky structure.
- 3. 28 to 42 inches, dark-gray (2.5Y 4/1), very plastic clay; massive (structureless).

Use and suitability.—Because of high fertility, all areas of this soil are farmed intensively. Corn, soybeans, and wheat are the principal crops; yields are generally high. Crops are infrequently damaged by floods. (Capability unit IIw-1.)

Wabash clay (Wb).—This is a black, fine-textured soil of the bottom lands. Locally, it is called gumbo. Areas in shallow depressions are difficult to drain and may remain idle in wet seasons. This soil is very inextensive and occurs on the flood plain of the Missouri River.

The black, very plastic clay surface layer is about 12 inches thick. It overlies a layer of very dark gray, very plastic clay that is about 24 inches thick. Below a depth of about 36 inches, the clay is dark gray, and in places it is mottled with yellowish brown.

Profile description (sec. 6, T. 47 N., R. 13 W.; three-fourths of a mile northeast of McBaine, between the Missouri-Kansas-Texas Railroad and Perche Creek):

- 1. 0 to 12 inches, black (10YR 2/1), very plastic clay; dark gray (10YR 4/1) and very hard when dry; moderate, medium, granular structure.
- 2. 12 to 36 inches, very dark gray (10YR 3/1), very plastic clay; massive (structureless).
- 3. 36 inches +, dark-gray (10YR 4/1), very plastic clay; massive (structureless).

Use and suitability.—Wheat and soybeans are the main crops. Because this soil has poor drainage and is difficult to cultivate when either wet or dry, corn is not grown extensively. Often, the soil is fall-plowed so that freezing and thawing during winter will improve the tilth. It is drained by surface ditches. This soil is less suitable for crops than Wabash silty clay loam. (Capability unit IIIw-14.)

Weldon silt loam, 2 to 4 percent slopes (Wc).—This light-colored, medium-textured soil occurs in the uplands on gently rolling relief. It is one of the more extensive soils of the county.

The brown to light-gray silt loam surface layer is about 5 inches thick. It overlies a layer of light yellowish-brown to pale-brown silt loam that is about 2 inches thick and generally has thin, platy structure. The upper subsoil begins at a depth of about 7 inches and is a yellowish-brown silty clay mottled with gray. Below a depth of about 30 inches, the subsoil consists of light-gray and yellowish-brown silty clay loam.

Profile description (sec. 2, T. 48 N., R. 14 W.):

- A₁ 0 to 5 inches, brown (10YR 5/3), very friable silt loam; light gray (10YR 7/2) when dry; weak, fine, granular structure.
- A₂ 5 to 7 inches, light yellowish-brown (10YR 6/4), very friable silt loam; very pale brown (10YR 7/3) when dry; weak, thin, platy structure with coatings of gray.
- B₂₁ 7 to 15 inches, light yellowish-brown (10YR 6/4), friable silty clay mottled with light gray (10YR 7/2); moderate, medium, subangular blocky structure; contains iron concretions.
- B₂₂ 15 to 30 inches, yellowish-brown (10YR 5/4), friable silty clay; light-gray (10YR 7/2) mottles; moderate, medium, subangular blocky structure; contains iron and manganese concretions.
- B₃ 30 inches +, mottled light-gray (10YR 7/2) and yellowish-brown (10YR 5/4) silty clay loam; weak, medium, subangular blocky structure.

Use and suitability.—Corn and wheat are the major grain crops on this soil. Forage crops consist mainly of lespedeza, redtop, and bluegrass. This soil is low in organic matter and in natural fertility. Without additions of lime and fertilizer, yields of all crops are low. This soil is very responsive to fertilizer, however. Management practices that will control erosion should be used. (Capability unit IIIe-5.)

Weldon silt loam, 2 to 4 percent slopes, moderately eroded (Wd).—This soil is mainly in fields that have been cultivated intensely. In most places the plow layer is a mixture of part of the subsoil and the original surface layer. It has a lighter color and slightly finer texture than that of Weldon silt loam, 2 to 4 percent slopes.

Use and suitability.—All of the common grain and forage crops are grown on this soil. Because of the thinner surface layer, this soil needs more careful management for control of erosion than the uneroded Weldon soil. Additions of limestone and fertilizer will improve yields of crops. (Capability unit IVe-5.)

Weldon soils, 5 to 11 percent slopes (We).—This mapping unit consists of soils that vary in color and texture of the plow layer as the result of erosion. The soils are steeper and more hilly than the Weldon silt loams just described. In some places the plow layer consists mainly of the yellowish-brown original subsoil and has silty clay loam or silty clay texture. In other places most of the original surface soil remains, and the profile is similar to that described for Weldon silt loam, 2 to 4 percent slopes.

Use and suitability.—Most areas of these soils are in pasture. Unless they are terraced to control erosion, the areas should not be used for row crops. Crop yields are low unless the soils are limed and fertilized. (Capability unit IVe-5.)



Figure 6.—Aerial view of Winfield silt loam, 6 to 13 percent slopes. Moderately hilly relief, soil erosion, tree-bordered drainageways, and irregular fields characterize the landscape.

Westerville silt loam (Wf).—This is a light-colored, medium-textured soil that occurs on bottom lands along small streams. In some places near streambanks, the soil is darker and is moderately sandy or contains bands and streaks of very fine sand. This soil is of moderate extent.

The dark grayish-brown silt loam surface layer is about 12 inches thick. It overlies yellowish-brown silt loam that is mottled with gray.

Profile description (NE¼SE¼ sec. 19, T. 48 N., R. 13 W.):

- 1. 0 to 12 inches, dark grayish-brown (10YR 4/2), friable silt loam; weak, fine, granular structure.
- 2. 12 to 25 inches, yellowish-brown (10YR 5/4), friable silt loam mottled with light brownish gray (10YR 6/2); weak, medium, subangular blocky structure.
- 3. 25 to 36 inches, yellowish-brown (10YR 5/6), slightly plastic, heavy silt loam mottled with gray (10YR 6/1); massive (structureless).

Use and suitability.—Most of this soil is used for growing corn. Other grain crops and forage crops grow well, but clovers are not grown extensively. Some of the bottom lands are too narrow for easy cultivation and are used for pasture. The soil is deep, friable, and productive, but it is subject to flooding. Some areas are affected by seepage from adjacent soils of the uplands. Drainage is provided by open ditches. (Capability unit IIIw-1.)

Winfield silt loam, 6 to 13 percent slopes (Wg).—This is a deep, medium-textured, brown soil of the uplands (fig. 6). It is one of the river-hill soils. It is similar to the Menfro soils but contains more clay in the subsoil and has more distinct horizons. This rolling soil is moderately extensive.

The brown silt loam surface layer is about 9 inches thick. It overlies a layer of yellowish-brown silt loam that is about 4 inches thick. The upper subsoil of silty clay loam begins at a depth of about 13 inches and is strong brown to yellowish brown. The lower subsoil of silty clay loam begins at a depth of about 32 inches and is mottled light yellowish brown and light gray. Mottled light-gray and pale-brown silt loam occurs below a depth of about 40 inches.

Profile description (E $\frac{1}{2}$ sec. 1, T. 48 N., R. 14 W.; one-half mile south of Midway):

- A₁ 0 to 9 inches, brown (10YR 4/3), very friable silt loam; grayish brown (10YR 5/2) when dry; weak, fine, granular structure.
- A₂ 9 to 13 inches, yellowish-brown (10YR 5/4), very friable silt loam; pale brown (10YR 6/3) when dry; weak, fine, granular structure.
- B₂₁ 13 to 24 inches, strong-brown (7.5YR 5/6), very friable silty clay loam; light yellowish brown (10YR 6/4) when dry; moderate, medium, subangular blocky structure.
- B₂₂ 24 to 32 inches, yellowish-brown (10YR 5/4), very friable silty clay loam; weak, medium, subangular blocky structure.
- B₂₃ 32 to 40 inches, mottled light yellowish-brown (10YR 6/4) and light-gray (10YR 7/2), very friable silty clay loam; weak, medium, subangular blocky structure.
- C 40 inches +, mottled light-gray (10YR 7/2) and pale-brown (10YR 6/3), heavy silt loam; massive (structureless)

Use and suitability.—This soil is easily tilled and is suited to many kinds of crops, mainly corn, wheat, clover, and alfalfa. Tobacco and apples are minor crops. Bluegrass thrives and is the main pasture grass. On strong slopes it is difficult to control erosion by terracing because gullying may occur at the drainage outlets. The frequent inclusion of grass in the cropping system helps to control erosion and to increase the amount of organic matter. (Capability unit IIIe-6.)

Winfield silty clay loam, 6 to 13 percent slopes, severely eroded (Wh).—This soil differs from Winfield silt loam, 6 to 13 percent slopes, in having lost nearly all the original surface soil because of erosion. The plow layer consists mainly of subsoil material that is lighter in color and has a texture of silty clay loam.

Use and suitability.—All of the common crops of the county are grown on this soil. It is somewhat difficult to till because of the clayey plow layer and because of the few gullies. Surface runoff is more rapid and the hazard of erosion is greater than on Winfield silt loam, 6 to 13 percent slopes. Also, more careful management is needed for control of erosion. (Capability unit IVe-6.)

Winfield soils, 14 to 19 percent slopes (Wk).—This mapping unit consists of soils that vary in color, texture, and thickness of the surface layer. In relatively uneroded spots, the soils have a profile similar to that described for Winfield silt loam, 6 to 13 percent slopes. In many places, however, the plow layer consists mainly of subsoil material that is lighter in color and heavier in texture.

Use and suitability.—These soils are too steep to terrace effectively. They will produce good pasture. Careful management should be used when renovating pastures for the control of erosion. (Capability unit VIe-1.)

Winfield soils, 20 to 30 percent slopes (Wl).—This mapping unit consists of steep soils that vary in color and texture of the surface layer. In many places the surface layer consists mostly of the subsoil material that is light-colored silty clay loam. Some spots still have part of the original silt loam surface soil and are darker. Many areas are gullied.

Use and suitability.—Most of the areas are in pasture or woodland. This is their best use, as the slopes are too steep and gullied for terracing and for cultivation. Extreme care should be used when reseeding. New plant-

ings in pasture or woodland should be on the contour. (Capability unit VIIe-6.)

General Soil Areas

In most localities it is easy to see differences in the landscape as one travels from place to place. There are differences in steepness, length, and shape of the slope; in the size and speed of the streams; in the kinds of native plants or the crops; and in the soils. Some differences in the soils are easily seen, but others are hidden beneath the surface.

By drawing lines around the different patterns of soils on a small-scale map, one can obtain a general map of the soils. Each kind of pattern is called a general soil area, or soil association. The pattern, of course, is not strictly uniform in each general soil area, but the same soils are present in somewhat the same arrangement. Such a map is useful to those who want a general idea of the soils, who want to compare different parts of a county, or who want to locate large areas suitable for some particular kind of farming or other broad land use. It does not show accurately the kinds of soils on a single farm or a small tract.

The eight general soil areas, or soil associations, in Boone County are shown on the general soil map that occurs with the detailed map that accompanies this report. The areas are given local descriptive names, as well as names of the major soil series in them. Soils of other series, however, may be present in any of the areas. Also, the major soil series of one area may occur in the other areas. Each general soil area has a distinct pattern of soils, and the soil differences are important to the farms within each area. The Putnam-Mexico association and the Onawa-Ray-Sharon association are the most important agricultural areas in the county.

1. Thin Loess Prairie: Putnam-Mexico Association

This general soil area consists of nearly level prairie, mainly in the northeastern part of the county. It extends southward in two long, narrow prongs, one from Centralia to beyond Ashland, and the other from Centralia to Columbia. The soils have a dark-gray, medium-textured surface soil and a dense clay subsoil.

Practically all of the soils of this area are under cultivation and are easily farmed. They are productive when limed and fertilized and are suited to all grain and forage crops grown in this region. The major management problem is improving soil fertility by proper fertilization.

2. Woodlandville Prairie: Seymour Association

This general soil area consists of gently sloping, dark-colored prairie soils. It is a fairly small area that averages about 1 mile in width and is about 6 miles long. It extends southward from near Woodlandville to beyond U.S. Highway No. 40. The darker color of the surface soil and the rolling relief are the more apparent

features that distinguish this area from the Putnam-Mexico association.

The soils of this area are among the most suitable for general farming. They are productive when limed and fertilized and are suited to all grain and forage crops grown in this region. The major management problem is improving soil fertility by proper fertilization.

3. White Oak Land: Lindley-Hatton Association

This general soil area is the most extensive and variable of the major soil areas. The light-colored Lindley soils predominate and are characterized by a fairly thin surface soil and low fertility. All of the area was originally forested, and the light-colored soils are locally called white oak land.

The Lindley-Hatton association can be divided into two main topographical areas. These areas are separated by the nearly level area of the Putnam-Mexico association that extends from Centralia to Columbia. In the northwestern part of the county in the drainage area of Perche Creek, Silver Fork, and Rocky Fork, the Lindley-Hatton association is extensively dissected. Here, it has short, steep slopes that are nonarable and mainly in forest. In the eastern part of the county in the drainage area of Hinkson and Cedar Creeks, the topography is predominantly rolling, and most of the land is farmed. The major management problems are controlling erosion and improving soil fertility.

4. Prairie-Timber Transition: Gara Association

The Gara association occurs throughout the county in a number of small areas where prairie soils grade into timber soils. These areas were originally covered by prairie grasses and later by trees. The soils, therefore, have some characteristics of both timber and prairie soils. A large area occurs northeast of Woodlandville.

Soils of the Gara association are somewhat better drained than soils of the Seymour association. They are more subject to erosion, however, because of stronger slopes. They are productive when limed and fertilized and are suited to crops and pasture, if properly managed.

5. Thin Loess Timber: Weldon-Union Association

This general soil area consists of a broad band of rolling to moderately hilly, light-colored soils. It borders the Winfield association on the east. The dominant soils have a well-developed profile that contains more clay than that of the Winfield soils. The loess material from which the Weldon soils are derived is less than 10 feet thick. Where erosion has removed the loess, the underlying till and limestone rocks are exposed. There are more variations in the soils of this area, therefore, than in soils of the Winfield association that have formed in thicker loess.

Most of the soils of this area are suited to cultivation, but they are used mainly for pasture. These soils have

some erosion but fewer gullies than the adjacent Winfield and Lindley soils. Most slopes are favorable for terracing. Although low in natural fertility, the soils are very responsive to treatment. Lespedeza, redtop, and bluegrass are the main forage crops. Corn and wheat are also grown. All yields are low unless lime and fertilizer are added.

6. Sloping River-Hill Land: Winfield Association

The Winfield association occurs in a continuous strip about 2 miles wide. It is bordered by the steep river-hill bluffs of the Menfro association on the west and by the Weldon-Union association on the east. Near the western edge of the county, north of U.S. Highway No. 40, the Winfield association adjoins the Seymour association.

The soils in the Winfield association are not so steep as the soils of the Menfro association. Most slopes range from 6 to 13 percent, but some range from 6 to 30 percent. The soils are less permeable and lower in fertility than those of the Menfro association. Also, they have formed in thinner loess and are more acid.

The soils of the Winfield association are suited to the major crops, but they should not be farmed intensively, because of the hazard of erosion. Most of the slopes are irregular and difficult to terrace. The area is best suited to livestock farming, and pastures are very productive when properly managed.

7. Steep River-Hill Bluffs: Menfro Association

This general soil area is characterized by hilly relief and the brown color of the deep loess in which the moderately developed soils have formed. It forms a continuous strip, about 2 to 3 miles wide, that is adjacent to the bottom lands of the Missouri River. The eastern edge of the area blends into the less steep area of the adjacent Winfield association.

Because of the hilly relief and the silty texture and permeability of the soils, the hazard of erosion is serious. The fairly high natural fertility of some soils has been modified by the loss of surface soil through erosion. Approximately 50 percent of the area is unsuitable for cultivation and is used for pasture and forest. Erosion is difficult to control by terracing; therefore, contouring, stripcropping, and frequent or continuous growing of grass are the usual management practices.

Because of high soil fertility, many areas that have slopes steeper than 20 percent are in cultivation. Corn, wheat, grass, and alfalfa are the major crops. The soils are very responsive to nitrogen and phosphate fertilizers. They have a higher potential for improvement than other soils of the uplands.

8. Bottom Land: Onawa-Ray-Sharon Association

This general soil area consists of soils on bottom lands of the Missouri River and the major creeks. Similar

soils occur along the smaller creeks throughout the county.

Soils of this general area have a wide range in color, texture, and productivity. The very fertile soils are mainly of two general types—fine sandy loams and dark-colored clay loams. The soils on creek bottoms range from dark brown to gray and are predominantly silt loam. The gray soils are generally poorly drained.

Most areas of the bottom lands are subject to overflow, and yields vary on poorly drained sites. Small, narrow areas of creek bottoms are often used for permanent pasture. Most areas, however, are very productive and are farmed intensively. Corn is the main cultivated crop. Normally, high yields of corn, wheat, soybeans, clover, and alfalfa are obtained. Nitrogen fertilizer is often used to increase yields.

Use and Management of the Soils

In this section the system used by the Soil Conservation Service in grouping soils according to their capability is explained. The soils are arranged in capability units, and management suggestions are given for the soils of each unit. In addition, estimated yields are given for principal crops grown under two levels of management, and the effect of soil treatments on soil productivity is discussed.

Capability Groups of Soils²

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally; for example, IIe-1 or IIIe-5.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows. The soils were assigned to capability units under a statewide system. Not all of the capability units in the State are represented in Boone County; consequently, the numbering of the units is not consecutive.

Class I. Soils that have few limitations that restrict their use.

Capability unit I-1.—Deep, well-drained, nearly level soils of the bottom lands.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion if they are not protected.

Capability unit IIe-1.—Deep, well-drained, nearly level soils on terraces.

Subclass IIw. Soils that have moderate limitations because of excess water.

Capability unit IIw-1.—Deep, poorly drained, moderately fine and fine textured soils of the bottom lands.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Capability unit IIIe-1.—Deep, well drained and moderately well drained, gently sloping soils of the uplands.

Capability unit IIIe-5.—Imperfectly drained, medium-textured, nearly level and gently sloping soils on terraces and in uplands.

Capability unit IIIe-6.—Deep, moderately well drained, moderately sloping soils of the uplands.

Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.

Capability unit IIIs-1.—Moderately deep, somewhat excessively drained, droughty, light-

² This section, as well as the section "Management by Capability Units," was prepared by HAROLD E. GROGGER, Soil Conservation Service, and is based on land-use capability interpretations used in the Boone County Soil Conservation District program.

colored, nearly level soils of bottom lands that are subject to flooding.

Subclass IIIw. Soils that have severe limitations because of excess water.

Capability unit IIIw-1.—Deep, poorly drained, medium-textured soils of the bottom lands.

Capability unit IIIw-3.—Poorly drained, nearly level upland and terrace soils with claypans.

Capability unit IIIw-14.—Deep, very poorly drained, fine-textured soils of the bottom lands.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Capability unit IVe-1.—Deep, well-drained, strongly sloping soils of the uplands.

Capability unit IVe-2.—Moderately sloping soils underlain by shale or limestone, generally at a depth of 20 to about 40 inches.

Capability unit IVe-5.—Gently to moderately sloping, imperfectly drained, eroded soils of the uplands.

Capability unit IVe-6.—Deep, moderately well drained, moderately sloping, eroded soils of the uplands.

Subclass IVs. Soils that have very severe limitations because of stoniness, low moisture capacity, or other soil features.

Capability unit IVs-4.—Deep, excessively drained, sandy soils of the bottom lands.

Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover. (None of the soils in Boone County have been placed in class V.)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Capability unit VIe-1.—Strongly sloping to steep, eroded soils of the uplands.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Capability unit VIIe-6.—Deep, moderately well drained, moderately steep to steep soils of the uplands.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Capability unit VIIs-6.—Shallow, moderately steep to steep, stony soils and miscellaneous land types of the uplands.

Class VIII. Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants; and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIs. Rock or soil materials that have little potential for production of vegetation.

Capability unit VIIIs-1.—Riverwash and Strip mines suited only to wildlife and recreation.

Management by Capability Units ³

In table 5 the soils of Boone County have been grouped in capability units or, as they are sometimes called, management groups. All the soils in one unit need about the same kind of management, respond to management in about the same way, and have essentially the same limitations. For each unit, suitable cropping systems or other uses are suggested in combination with different management practices. In addition to the cropping systems listed, other cropping systems that will effectively control erosion can be used.

³ See footnote 2, page 20.

TABLE 5.—*Soils of Boone County arranged by capability units, and cropping systems or uses suitable with different supporting practices*

Capability units and soils	Suitable cropping systems or uses with—			Remarks
	No contouring or terracing	Contour farming	Terracing	
Unit I-1..... Ray silt loam. Salix loam. Sarpy very fine sandy loam. Sharon silt loam.	Continuous row crops under excellent management practices.	Not needed.....	Not needed.....	Crops: Return all crop residues to the soil; apply adequate amounts of lime and fertilizer, including nitrogen; small grain seeded with a legume or grass can be grown occasionally to help maintain tilth and the content of organic matter. Pasture: Apply nitrogen fertilizer on grasses grown for early pasture.
Unit IIe-1..... Menfro silt loam, terrace phase, 1 to 3 percent slopes.	2 years of row crops, 1 year of small grain, and 2 years of meadow.	2 years of row crops, 1 year of small grain, and 1 year of meadow.	2 or 3 years of row crops, 1 year of small grain seeded with a green-manure crop.	Crops: Apply lime and fertilizer according to needs determined by soil tests; use nitrogen fertilizer on second-year corn; return all crop residues to the soil; maintain waterways in sod. Pasture: Apply lime and fertilizer as needed; clip weeds; regulate grazing; do not graze unless grass is at least 4 inches high.
Unit IIw-1..... Onawa silty clay. Onawa silty clay loam. Wabash silty clay loam.	3 years of row crops, 1 year of small grain, and 1 year of meadow; with highly specialized management (see remarks for unit I-1), continuous row crops can be grown if soils are seeded to a cover crop.	Not needed.....	Not needed.....	Crops: These soils are subject to flooding; surface ditches are needed to provide drainage. Pasture: Do not permit cattle to graze or trample grass when the soil is too wet.
Unit IIIe-1..... Dennis silt loam, 3 to 7 percent slopes. Menfro silt loam and silty clay loam, 6 to 13 percent slopes.	1 year of small grain, 1 or more years of meadow.	1 year of a row crop, 1 year of small grain, and 2 years of meadow.	2 years of row crops, 1 year of small grain, and 2 years of meadow.	Crops: Control of erosion is a major problem; drainageways should be made wide enough and should be grassed so that they remove water safely. Pasture: These soils will puddle and become compact if pastured when wet; apply nitrogen fertilizer to obtain early grazing.
Unit IIIe-5..... Freeburg silt loam, dark-surface variant. Mexico silt loam, 1 to 3 percent slopes. Mexico silt loam, light-gray variant, 1 to 3 percent slopes. Pershing silt loam, 2 to 4 percent slopes. Seymour silt loam, 2 to 4 percent slopes. Seymour silt loam, 3 to 7 percent slopes, moderately eroded. Weldon silt loam, 2 to 4 percent slopes.	1 year of a row crop, 1 year of small grain, and 3 years of meadow.	1 year of a row crop, 1 year of small grain, and 2 years of meadow.	2 years of row crops, 1 year of small grain, and 1 year of meadow.	Crops: Fertilizer is needed for optimum yields; further erosion will reduce productivity; drainageways should be made wide enough and should be grassed so that they remove water safely. Pasture: Apply lime and fertilizer according to needs determined by soil tests; use nitrogen fertilizer to obtain early grazing; do not graze when the soils are too wet; mow frequently so that grasses will not smother legumes.

TABLE 5.—*Soils of Boone County arranged by capability units, and cropping systems or uses suitable with different supporting practices—Continued*

Capability units and soils	Suitable cropping systems or uses with—			Remarks
	No contouring or terracing	Contour farming	Terracing	
Unit IIIe-6----- Gamma soils, 5 to 8 percent slopes. Gara loam, 5 to 8 percent slopes. Gara loam, 5 to 9 percent slopes, moderately eroded. Hatton silt loam, 3 to 7 percent slopes. Union silt loam, 3 to 8 percent slopes. Winfield silt loam, 6 to 13 percent slopes.	1 year of small grain, 1 or more years of meadow.	1 year of a row crop, 1 year of small grain, and 3 years of meadow.	2 years of row crops, 1 year of small grain, and 2 years of meadow.	Crops: The moderately heavy subsoil of these soils restricts permeability and causes excessive runoff of rainfall, and as a result, the risk of erosion is high and the moisture-supplying capacity is reduced; lime and fertilizer are needed. Pasture: These soils puddle and become compact if pastured when wet; apply lime and fertilizer according to the results of soil tests; use nitrogen fertilizer to obtain early grazing; mow when grass becomes too high.
Unit IIIs-1----- Sarpy loamy fine sand. Sharon silt loam, gravel-substratum variant.	2 years of row crops, 1 year of small grain, and 1 year of meadow.	Not needed-----	Not needed-----	Crops: These soils are well suited to vegetables and melons; plowing under green-manure crops will help maintain organic matter and improve the moisture-supplying capacity. Pasture: Nitrogen fertilizer will help to provide early grazing; because pasture will not hold up well in dry periods, deep-rooted legumes should be seeded.
Unit IIIw-1----- Moniteau silt loam. Stet silt loam. Westerville silt loam.	2 years of row crops, 1 year of small grain, and 1 year of meadow; with highly specialized management (see remarks for unit I-1), 3 years of row crops, 1 year of small grain seeded to a cover crop.	Not needed-----	Not needed-----	Crops: These soils are subject to flooding, and some areas are affected by seepage from soils of the uplands; drainage is provided by open ditches. Pasture: These soils will puddle and become compact if pastured when wet; apply lime and fertilizer according to needs determined by soil tests.
Unit IIIw-3----- Chauncey silt loam, 0 to 1 percent slopes. Marion silt loam, 1 to 3 percent slopes. Putnam silt loam, 0 to 2 percent slopes. Racoon silt loam, 1 to 3 percent slopes.	2 years of row crops, 1 year of small grain, and 1 year of meadow; with highly specialized management (see remarks for unit I-1), 3 years of row crops, 1 year of small grain seeded to a cover crop.	Not needed-----	Not needed-----	Crops: Lime and fertilizer are needed for optimum yields; tile will not work adequately because of the tight claypan in the subsoil; surface ditches are needed to remove excess water. Pasture: Apply lime and fertilizer according to the results of soil tests; do not pasture when soils are wet; control grazing and mowing to maintain a good growth of legumes and grasses.
Unit IIIw-14----- Carlow silty clay, high-bottom phase. Wabash clay.	3 years of row crops, 1 year of small grain seeded with a green-manure crop; with highly specialized management (see remarks for unit I-1), continuous row crops can be grown if a grass cover crop is established by seeding at the last cultivation and if the cover crop is not plowed until late in spring.	Not needed-----	Not needed-----	Crops: Fall plowing is a common practice on these soils; response to fertilizer varies according to the wetness of the season and the drainage of the soils; tile does not work well; use surface ditches to drain the soils. Pasture: These soils are not suited to early grazing; they will puddle if grazed when wet; seed pasture to legumes and grasses that tolerate wetness.

TABLE 5.—*Soils of Boone County arranged by capability units, and cropping systems or uses suitable with different supporting practices—Continued*

Capability units and soils	Suitable cropping systems or uses with—			Remarks
	No contouring or terracing	Contour farming	Terracing	
Unit IVE-1----- Menfro silt loam and silty clay loam, 14 to 19 percent slopes.	1 year of small grain, 2 or more years of meadow.	1 year of small grain, 2 or more years of meadow.	1 year of a row crop, 1 year of small grain, and 3 years of meadow.	Crops: The soils erode easily and terracing generally is impractical because of the irregular, short slopes; they respond well to nitrogen and phosphate fertilizers. Pasture: Apply nitrogen fertilizer to obtain early grazing; mow pasture and control grazing; do not graze when wet.
Unit IVE-2----- Mandeville silt loam, 5 to 8 percent slopes. Snead silty clay, 7 to 12 percent slopes.	1 year of small grain, 1 or more years of meadow.	1 year of small grain, 1 or more years of meadow.	1 year of a row crop, 1 year of small grain, and 3 years of meadow.	Crops: Terracing may not be feasible because of the shallow depth to shale or limestone; apply lime and fertilizer according to needs determined by soil tests; drainageways should be properly designed and grassed so that they remove excess water safely. Pasture: Fertilize according to the results of soil tests; apply nitrogen fertilizer if early pasture is desired; do not graze when the soil is wet.
Unit IVE-5----- Mexico silt loam, 2 to 4 percent slopes, moderately and severely eroded. Sapp soils, 3 to 5 percent slopes. Weldon silt loam, 2 to 4 percent slopes, moderately eroded. Weldon soils, 5 to 11 percent slopes.	1 year of small grain, 1 or more years of meadow.	1 or 2 years of small grain, 2 or more years of meadow.	1 year of corn, 1 year of small grain, and 1 year of meadow.	Crops: Because the fine-textured subsoil is exposed, maintaining tilth is a major problem; unless lime and fertilizer are applied, yields are low. Pasture: These soils will puddle and become compact if grazed when wet; apply lime and fertilizer according to needs determined by soil tests.
Unit IVE-6----- Gamma soils, 9 to 12 percent slopes. Gara clay loam, 5 to 9 percent slopes, severely eroded. Lindley loam and clay loam, 5 to 8 percent slopes. Winfield silty clay loam, 6 to 13 percent slopes, severely eroded.	1 year of small grain, 1 or more years of meadow.	1 year of small grain, 1 or more years of meadow.	1 year of a row crop, 1 year of small grain, and 3 years of meadow.	Crops: Lime and fertilizer are needed to obtain optimum yields; erosion-control practices are required; drainageways should be properly designed and grassed for safe removal of excess water. Pasture: Do not graze when soils are wet; apply lime and fertilizer according to needs determined by soil tests; use nitrogen fertilizer to obtain early grazing.
Unit IVs-4----- Sarpy sand.	1 year of a row crop, 1 year of small grain, and 2 years of meadow; with highly specialized management (see remarks for unit I-1), row crops can be grown more often.	Not needed-----	Not needed-----	Crops: Wind erosion is a hazard on this soil; stripcropping is often needed to control wind erosion; specialized crops, such as vegetables and melons, will produce good yields. Pasture: Because pasture does not hold up well during dry periods, deep-rooted legumes should be seeded.

TABLE 5.—*Soils of Boone County arranged by capability units, and cropping systems or uses suitable with different supporting practices—Continued*

Capability units and soils	Suitable cropping systems or uses with—			Remarks
	No contouring or terracing	Contour farming	Terracing	
Unit VIe-1----- Lindley loam and clay loam, 9 to 15 percent slopes. Mandeville silt loam and silty clay loam, 9 to 16 percent slopes. Menfro silt loam and silty clay loam, 20 to 50 percent slopes. Union silt loam and silty clay loam, 9 to 16 percent slopes. Winfield soils, 14 to 19 percent slopes.	Pasture or woodland---	Pasture or woodland; new seedlings should be on the contour.	Pasture or woodland; new seedlings should be on the contour.	Pasture: Permanent pastures should be renovated occasionally with applications of lime and fertilizer; grazing should be regulated so that good cover will be maintained; pastures should not be grazed or trampled when the soils are wet; diversion terraces may be needed to control gullying. Woodland: Areas of woodland should not be pastured; undesirable trees should be removed, and trees planted should be suited to the soils and climate; new seedlings should be set in furrows on the contour; protect woodland from fire.
Unit VIIe-6----- Lindley loam, 16 to 25 percent slopes. Winfield soils, 20 to 30 percent slopes.	Pasture or woodland---	Pasture or woodland; new seedlings should be on the contour.	Not needed-----	Pasture: It may be best to renovate pastures by use of contoured strips; leave alternate strips of vegetation to protect the slopes from erosion while a good stand of grass becomes established on the renovated strips; then, renovate the alternate strips. Woodland: Areas of woodland should not be pastured; undesirable trees should be removed, and the trees planted should be suited to the soils and the climate; new seedlings should be set in furrows on the contour; protect woodland from fire.
Unit VIIIs-6----- Gosport stony silt loam, 11 to 30 percent slopes. Snead stony clay loam, 11 to 30 percent slopes. Steep stony land, 15 to 50 percent slopes.	Pasture or woodland---	Pasture or woodland; new seedlings should be on the contour.	Not needed-----	Pasture: Low moisture-supplying capacity limits the production of grass; stones may interfere with seeding and mowing operations. Woodland: Areas of woodland should not be pastured; undesirable trees should be removed, and the trees planted should be suited to the soils and the climate; new seedlings should be set in furrows on the contour; protect woodland from fire.
Unit VIIIIs-1----- Riverwash. Strip mines.	Wildlife or recreation---	Wildlife or recreation.	Wildlife or recreation.	Riverwash: Cottonwood and willow trees are the main vegetation. Strip mines: These areas vary in acidity and alkalinity; tolerant grasses and trees, such as lespedeza, sweetclover, broomsedge, weeds, cottonwood, buckbrush, and other natural species should be encouraged to provide cover.

Estimated Yields

Estimated average acre yields of principal crops on the soils of Boone County are listed in table 6. In col-

umns A are yields to be expected under average management, and in columns B are yields to be expected under the improved management now used by some farmers in the county.

TABLE 6.—*Estimated average acre yields of principal crops under two levels of management*

[Yields in columns A are those expected under average management, and yields in columns B are those expected under improved management. Absence of a yield figure indicates the crop is not commonly grown at the management level indicated. The miscellaneous land types Riverwash and Strip mines are not suitable for cultivation and have been omitted from the table]

Soil	Corn		Soybeans		Oats		Rotation hay		Pasture	
	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Lbs. beef per acre	Lbs. beef per acre
Carlow silty clay, high-bottom phase.....	30	45	20	25	25	35	1.0	1.75	150	225
Chauncey silt loam, 0 to 1 percent slopes.....	46	80	27	32	32	45	2.5	3.0	225	300
Dennis silt loam, 3 to 7 percent slopes.....	55	77	27	35	40	50	2.5	3.5	200	250
Freeburg silt loam, dark-surface variant.....	43	65	20	28	30	40	2.0	3.0	250	325
Gamma soils, 5 to 8 percent slopes.....	47	65	20	28	30	40	1.5	2.5	200	275
Gamma soils, 9 to 12 percent slopes.....	40	50	17	22	27	38	1.5	2.5	200	275
Gara loam, 5 to 8 percent slopes.....	60	73	25	33	33	45	2.0	3.0	200	300
Gara loam, 5 to 9 percent slopes, moderately eroded.....	50	65	20	30	30	40	1.5	2.75	225	300
Gara clay loam, 5 to 9 percent slopes, severely eroded.....	28	40	15	20	20	38	1.5	2.5	100	200
Gosport stony silt loam, 11 to 30 percent slopes.....									75	100
Hatton silt loam, 3 to 7 percent slopes.....	30	50	15	20	28	33	1.5	2.5	200	250
Lindley loam and clay loam, 5 to 8 percent slopes.....	30	50	15	20	25	35	1.0	2.5	150	250
Lindley loam and clay loam, 9 to 15 percent slopes.....					20	30	1.0	2.0	100	200
Lindley loam, 16 to 25 percent slopes.....							1.0	2.0	100	200
Mandeville silt loam, 5 to 8 percent slopes.....	25	35	10	20	20	30	1.0	2.0	150	200
Mandeville silt loam and silty clay loam, 9 to 16 percent slopes.....					20	25	1.0	2.0	150	200
Marion silt loam, 1 to 3 percent slopes.....	30	50	15	25	30	35	1.5	2.0	100	200
Menfro silt loam, terrace phase, 1 to 3 percent slopes.....	57	85	30	40	45	60	2.5	3.5	250	300
Menfro silt loam and silty clay loam, 6 to 13 percent slopes.....	55	75	25	35	38	50	2.5	3.5	200	250
Menfro silt loam and silty clay loam, 14 to 19 percent slopes.....					30	37	2.5	3.5	200	250
Menfro silt loam and silty clay loam, 20 to 50 percent slopes.....									150	200
Mexico silt loam, 1 to 3 percent slopes.....	45	74	23	30	35	45	2.5	3.5	250	325
Mexico silt loam, 2 to 4 percent slopes, moderately and severely eroded.....	25	35	15	20	20	30	1.0	2.5	150	225
Mexico silt loam, light-gray variant, 1 to 3 percent slopes.....	43	72	20	28	33	40	2.5	3.0	250	300
Moniteau silt loam.....	32	45	20	25	25	35	1.0	2.0	150	200
Onawa silty clay loam.....	50	75	30	35	25	35	2.0	2.5	225	300
Onawa silty clay.....	45	70	27	33	25	30	2.0	2.5	200	275
Pershing silt loam, 2 to 4 percent slopes.....	45	80	25	30	35	45	2.5	3.5	250	350
Putnam silt loam, 0 to 2 percent slopes.....	45	78	25	30	35	45	2.5	3.5	250	325
Raccoon silt loam, 1 to 3 percent slopes.....	35	55	20	25	30	35	1.5	2.0	125	200
Ray silt loam.....	70	90	35	40	50	60	3.0	5.0	300	350
Salix loam.....	60	90	30	35	47	57	2.5	4.0	300	350
Sapp soils, 3 to 5 percent slopes.....	43	65	20	25	30	35	1.5	2.5	150	250
Sarpy loamy fine sand.....	30	45	25	35	20	25	1.5	2.0	125	200
Sarpy sand.....	35	40	15	20	15	20	1.0	1.5	100	200
Sarpy very fine sandy loam.....	65	85	28	35	45	52	2.5	3.5	250	300
Seymour silt loam, 2 to 4 percent slopes.....	50	75	25	36	35	45	2.5	3.5	250	325
Seymour silt loam, 3 to 7 percent slopes, moderately eroded.....	45	67	20	32	30	40	2.0	3.0	250	325
Sharon silt loam.....	70	90	32	38	50	57	3.0	5.0	250	300
Sharon silt loam, gravel-substratum variant.....	27	42	20	30	20	25	1.25	1.75	100	175
Snead silty clay, 7 to 12 percent slopes.....	20	30	10	15	20	30	1.0	2.0	150	200
Snead stony clay loam, 11 to 30 percent slopes.....									100	150
Steep stony land, 15 to 50 percent slopes.....									75	100
Stet silt loam.....	40	60	25	30	30	40	2.0	3.0	225	275
Union silt loam, 3 to 8 percent slopes.....	50	65	25	30	30	45	1.5	3.0	200	250
Union silt loam and silty clay loam, 9 to 16 percent slopes.....					20	35	1.5	2.5	150	200
Wabash silty clay loam.....	45	75	27	35	30	40	2.0	2.5	200	275
Wabash clay.....	40	60	25	32	25	35	2.0	2.5	150	250
Weldon silt loam, 2 to 4 percent slopes.....	35	45	17	25	25	35	1.5	3.5	175	225
Weldon silt loam, 2 to 4 percent slopes, moderately eroded.....	30	35	15	25	25	30	1.0	2.0	100	200
Weldon soils, 5 to 11 percent slopes.....	30	33	15	20	20	27	1.5	2.5	150	200
Westerville silt loam.....	45	70	22	28	30	40	1.5	2.0	150	225
Winfield silt loam, 6 to 13 percent slopes.....	50	65	25	30	30	45	1.5	3.0	200	250
Winfield silty clay loam, 6 to 13 percent slopes, severely eroded.....	30	45	15	20	20	30	1.0	2.0	150	200
Winfield soils, 14 to 19 percent slopes.....					20	35	1.5	2.5	150	200
Winfield soils, 20 to 30 percent slopes.....							1.5	2.5	150	200

The yields are estimated averages for a 5- to 10-year period. They do not take into account abnormal seasons or the past management of a soil on a particular farm. The yields are based on interviews with farmers, members of the staff of the Missouri Agricultural Experiment Station, representatives of the Soil Conservation Service, and others familiar with the agriculture of the county. In making the estimates, the prevailing climate, characteristics of the soils, and the influence of different kinds of management on the soils were considered.

To obtain the yields in columns A, farmers should use the following management:

- (1) Lime and fertilizer are applied according to needs determined by soil tests.
- (2) A cropping system that includes meadow is followed.
- (3) When available, barnyard manure is applied on fields.
- (4) A starter fertilizer is used on corn.
- (5) Weeds are controlled by timely cultivation or by using chemicals.
- (6) Plowing and cultivating are done across the slope instead of up and down the hill.
- (7) Fields are drained, but low spots in some fields are not leveled.

To obtain the yields in columns B, farmers should apply the following management:

- (1) Larger amounts of fertilizer, particularly nitrogen, are used than in management producing the yields in columns A.
- (2) Cropping systems that will adequately control erosion are used. (The use of more intensive cropping systems than those suggested in table 5 will result in excessive loss of soil and fertility.)
- (3) Barnyard manure and starter fertilizer are used.
- (4) Weeds, diseases, and insects are controlled by the best-known methods.
- (5) Recommended varieties of crops are grown and recommended planting rates are followed.
- (6) Crop residues are returned to the soil.
- (7) The soil is adequately drained, and low spots are leveled.

Even higher yields than those shown in columns B may be obtained. Many farmers produce more than 100 bushels of corn per acre, especially in favorable seasons. On some soils, it may pay to make heavy applications of nitrogen and other fertilizers, possibly fertilizer containing some minor elements, such as boron. Consult your county agent, members of the staff of the State Experiment Station, or the technicians working with the local Soil Conservation District for specific suggestions on kinds and amounts of fertilizers and lime to apply and on seed mixtures to use.

Effect of Soil Treatment on Productivity of the Soils ⁴

Corn is grown on most of the soils in Boone County. Yields of corn frequently have been used to indicate

⁴ This section prepared by Dr. G. E. SMITH, chairman, Department of Soils, University of Missouri.

the potential productivity and agricultural value of the various soils. Much of the sloping land has been modified by erosion. Acreage in corn is largely limited to the more nearly level soils or to soils productive enough to justify terracing or other water-management practices. Much of the eroded area is now used for pastures.

In the last 15 years, the use of liberal soil treatment has improved productivity in many soils. In 1945, a total of 1,500 tons of commercial fertilizer was used in the county.⁵ The amount used increased to 7,700 tons in 1950 and to 11,000 tons in 1959. From 1945 to 1959, the percentage of nutrients in mixed fertilizer increased from 21 to more than 36. The availability of low-cost chemical nitrogen has been a major factor in this increase.

The fairly low content of organic matter in the soils and the inability of legumes and manure to provide enough nitrogen previously had limited yields of crops. Additional nitrogen, however, has been applied, and phosphate and potash have been increased to balance it. Rock phosphate is used extensively in crop rotations that include legumes and in areas where improved pastures are established. Most soils of the uplands require additions of limestone for the growth of legumes and for reducing the fixation of phosphate. Little need for magnesium, sulfur, or trace elements has been found, although boron is needed on some soils of the uplands when alfalfa is grown.

Past management and weather greatly influence crop yields. If there is adequate moisture during the growing season, soils that have lost part of the surface layer will give a good response to fertilizer treatment. Soils high in organic matter produce good yields after limited treatment. The response to fertilizer is usually greatest in years that have an excess amount of moisture or when conditions are unfavorable for microbial activity. Nutrients may accumulate following dry seasons, and response to fertilizer is reduced. On claypan soils yields are likely to be decreased the next year after a wet season, if plant nutrients are not added.

Soil tests are used extensively to determine the nutrient reserves in the plow layer of the soil and to indicate the amount of fertilizer necessary for optimum yields. The needed soil treatment, however, may not be used because of the cost. In establishing land values on the basis of probable production after treatment, the cost of the treatment must be considered.

Claypan soils—Putnam and Mexico silt loams

Few soils in the State have increased as much in value through proper soil treatment as the Putnam and Mexico soils with claypans. Without soil treatment, growth of crops is slow in late, wet springs until the temperature is high enough to permit the release of nitrogen and phosphorus from organic matter. Legumes are beneficial as green-manure crops, but they use moisture that is needed in midsummer by corn and soybeans. Where ample lime, phosphate, and potash have been applied, nitrogen fertilizer can be added as a side dressing to fields planted to corn. Soybeans do not regularly respond to direct fertilization unless the soil is very

⁵ Statistics given in this section were taken from bulletins published by the University of Missouri Agricultural Experiment Station.

deficient in some element. Best yields of soybeans are obtained when they follow corn that has been liberally fertilized.

Table 7 gives yields obtained on Mexico silt loam, under various soil treatments, when crops are grown both continuously and in rotation.

TABLE 7.—Yields of crops per acre on Mexico silt loam (containing .2 percent organic matter) under different methods of cropping and soil treatment

Year	Continuous cropping of corn or wheat with the addition of—		Rotation of corn, wheat, and red clover with the addition of chemical fertilizer ²				
	Manure ¹		Chemical fertilizer ²				
	Corn	Wheat	Corn	Wheat	Corn	Wheat	Red clover
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Lbs.
1950	51.2		125.8		122.7		5,460
1951	40.0	18.0	111.8	33.9	134.2	30.1	4,410
1952	32.3	17.5	56.8	23.1	57.7	30.3	3,780
1953	24.7	25.6	72.8	33.7	65.0	35.1	3,790
1954	0	36.6	0	40.7	0	41.5	3,270
1955	48.3	26.8	80.1	42.6	74.2	34.6	9,280
1956	75.2	10.1	94.0	29.4	84.3	26.6	0
1957	30.9	18.4	66.0	23.5	55.4	17.5	0
1958	91.1	18.6	96.2	26.3	110.2	28.6	3,730
1959	25.2	19.0	35.0	27.7	38.4	40.5	4,600
Average	41.9	21.1	73.8	31.2	74.2	31.6	3,832

¹ Six tons per acre applied annually.

² Applied in amounts indicated by soil tests.

Application of fertilizer to claypan soils has consistently resulted in higher yields of crops in favorable seasons. The practice of growing corn continuously, rather than in a rotation, has increased in recent years on soils in which erosion is not a problem. In years when the amount of moisture is low in summer, corn grown after corn produces the highest yields; but in years when the supply of moisture is adequate, corn grown after clover produces the highest yields. Apparently, the clover extracts subsoil moisture that is needed by corn when rainfall in summer is inadequate. The fertilization of wheat and other small grains may increase the difficulty of establishing grasses or legumes because the small grains provide too much shade and deplete the supply of soil moisture. Consequently, legumes and grasses are now generally sown alone instead of being seeded in small grains. Alfalfa is not grown extensively; it requires heavy fertilization to provide satisfactory stands and yields.

Menfro, Winfield, and Weldon soils

Many areas of the Menfro, Winfield, and Weldon soils have lost much of their surface soil because of erosion. Favorable physical properties of the lower layers, however, make these areas responsive to additions of nitrogen. In fields where large amounts of legumes have been harvested for hay, the subsoil may have a higher content of phosphorus and potassium than the surface soil.

Variations in rainfall cause less variation in yields of wheat than in yields of corn and soybeans. The effects of soil treatment on yields of various crops grown on Weldon silt loam are shown in tables 8, 9, and 10.

TABLE 8.—Effect of fertilizer on yields of wheat grown on limed areas of Weldon silt loam

[Yield figures are averages for the period 1954 through 1959]

Soil treatment	Yields of wheat
None	Bu. per acre 26.8
250 pounds of 4-12-4 ¹ per acre	37.0
250 pounds of 4-12-4 and 33 pounds additional nitrogen per acre	42.8
250 pounds of 4-12-4 and 66 pounds additional nitrogen per acre	44.3

¹ Percentages of nitrogen, phosphate, and potash, respectively, in a 100-pound bag of complete fertilizer.

TABLE 9.—Effect of nitrogen on yields per acre of corn grown on Weldon silt loam

Soil treatment	1956	1957	1958	1959	4-year average
Starter fertilizer only	Bu. 53.8	Bu. 80.3	Bu. 26.9	Bu. 23.4	Bu. 46.1
Starter fertilizer and 60 pounds additional nitrogen per acre	79.8	94.0	92.7	37.3	76.0
Starter fertilizer and 120 pounds additional nitrogen per acre	97.3	99.0	106.5	38.2	85.3

TABLE 10.—Effect of soil treatment on average yields per year of alfalfa in a 5-year period on Weldon silt loam

Soil treatment	Yields of alfalfa
Limestone	Lbs. per acre 11,300
Limestone and phosphate	12,000
Limestone, phosphate, and potash	12,800
Double treatment of limestone, phosphate, and potash (plowed 12 inches deep)	13,600

Some of the highest yields of small grains on upland soils in the State have been produced on the Menfro, Winfield, and Weldon soils. Response to fertilizer usually depends on past management. An application of starter fertilizer, high in phosphate, is generally desirable, and a topdressing of nitrogen is beneficial.

The acreage of corn is limited because much of the land has steep slopes. Good yields are obtained when there is ample moisture as well as adequate fertility. Nitrogen is required, except when corn is grown following a good legume crop. The need for mineral treatments is highly variable and depends on past management.

Alfalfa thrives on these soils. Frequently, limestone is needed for obtaining good stands. The need for phosphorus and potassium varies according to variations in the soils.

Lindley soils

Good yields of small grains and pasture plants are obtained on the Lindley soils after corrective treatments have been made. Usually, 3 to 5 tons of limestone per acre are needed. The soils are low in available phosphorus. Rock phosphate frequently is applied as a basic treatment, and it is supplemented by a complete fertilizer applied at seeding time. Where the deficiency in nutrients has been corrected and moisture is not a limiting factor, yields of forage are comparable to those obtained on soils of higher natural fertility. The effect of fertilizer on yields of mixed forage obtained on Lindley loam is shown in table 11.

TABLE 11.—*Effect of fertilizer on yields of mixed forage (grass and legume) grown on limed areas of Lindley loam*

Soil treatment	Soil 1	Soil 2
	<i>Lbs. air-dry forage per acre</i>	<i>Lbs. air-dry forage per acre</i>
No fertilizer.....	2, 500	3, 700
Nitrogen only.....	2, 120	4, 460
Phosphate only.....	3, 830	6, 670
Nitrogen and phosphate.....	6, 530	6, 580
Nitrogen, phosphate, and potash.....	6, 740	7, 060

Soils of the bottom lands

The soils of the bottom lands occur on both river bottoms and on creek bottoms.

Soils on river bottoms.—These soils are rich in plant nutrients and show little response to added elements except nitrogen. Wheat is usually planted without soil treatment, but topdressing with 25 to 30 pounds of nitrogen per acre is a common practice. The response to nitrogen fertilizer is greatest on sandy soils and on those low in organic matter. In wet or late springs, a starter fertilizer containing nitrogen and phosphate may benefit corn. Nitrogen is generally applied to corn when it is knee high. The effect of nitrogen on yields of corn grown on soils of the river bottoms is shown in table 12.

TABLE 12.—*Effect of nitrogen on yields of corn grown on soils of the river bottoms*

Soil type	No nitrogen applied	80 pounds of nitrogen applied per acre
	<i>Bu. of corn per acre</i>	<i>Bu. of corn per acre</i>
Wabash silty clay loam (plot 1).....	69. 2	80. 8
Wabash silty clay loam (plot 2).....	74. 0	81. 5
Onawa silty clay loam (plot 1).....	99. 7	119. 5
Onawa silty clay loam (plot 2).....	84. 1	105. 5

Soils on creek bottoms.—These soils have formed in material washed from all the soils of the uplands. In



Figure 7.—Aerial view of Sanborn Experiment Field.

general, they are not so productive and are more variable in composition than the soils of the river bottoms. The light-colored soils, which generally occur on the higher bottoms, are less productive than the soils on low bottoms, and they may require limestone and fertilizer for the successful production of legumes. Nitrogen is applied to corn grown on low bottoms that are frequently flooded.

Soils in experiment fields

Research in soil management, including studies of fertilizers and crop rotations, has been conducted for many years on experiment fields of the University of Missouri. Results of this research have been published in Bulletins 458, 583, 657, and others of the Missouri Agricultural Experiment Station. These bulletins and other reports published by the experiment station can be obtained by writing the College of Agriculture, University of Missouri, Columbia, Mo.

Sanborn Experiment Field.—This experiment field was established in 1888. It is on the campus of the University of Missouri and within the city of Columbia (fig. 7). Mexico silt loam occupies all of the field except the eastern edge (right-hand side of figure 7), where it grades to Lindley loam. In most plots the surface soil has been modified by erosion and frequent cultivation and is reduced in thickness.

Long-time results have established that a crop rotation alone, or manure alone, will not maintain the productivity of the soil. The content of organic matter has decreased under almost all cropping systems tested. Lime is a primary need of the soil. Grass, grown in a rotation, is needed to help maintain the structure of the soil. Deterioration in soil structure has been greater under rotations that did not include a grass crop than under rotations that included grass.

University South Farm.—The experiment field on the University South Farm was established in 1931 (fig. 8). It is 3 miles southeast of Columbia, in the S $\frac{1}{2}$ sec. 28, T. 48, R. 12 W. Practically all of the experiment field used for fertility studies is made up of Mexico silt loam. This soil type is extensive in Boone County and elsewhere in northeastern Missouri. It is related to Putnam silt loam and is similar to this soil in its main features.

The experimental results and observations on Mexico silt loam are applicable to other soils that are similar in fertility and use. Mexico silt loam is of medium productivity. It is responsive to fertilization, as evi-

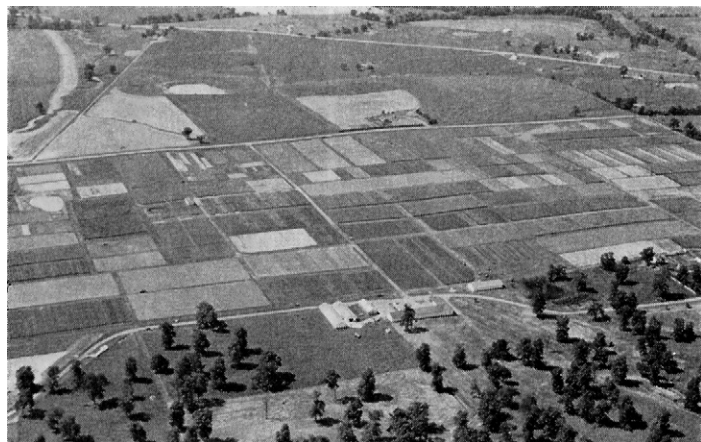


Figure 8.—Aerial view of University South Farm. Field plots consist of Mexico silt loam, and forested areas consist mainly of Weldon silt loam.

denced by continuous high yields when fertilizers are applied. It is suited to all the common grain and grass crops grown in Boone County. The soil requires lime for the successful production of clover and alfalfa.

Genesis, Classification, and Morphology of the Soils

In this section the factors of soil formation that affect the development of the soils in Boone County are discussed. In addition, the soil series in the county are classified by higher categories, the morphology of the soils is discussed, and laboratory data are given for some of them.

Factors of Soil Formation

Soil is formed by weathering and other processes that act on parent material. The characteristics of the soil at any given point depend upon (1) the climate, (2) the plant and animal life, (3) the physical and mineralogical composition of the parent materials, (4) the relief or lay of the land, and (5) time. The effect of climate on soil and plants is modified by the characteristics of the soil and by relief. Relief, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Climate

Boone County has a climate that is marked by extremes in temperature. The average annual precipitation is about 38 inches; a considerable part of this occurs during the growing season. The average annual snowfall is about 16 inches. The climate is fairly uniform throughout the county, and no major differences exist among the soils because of it.

Living organisms

Plants and animals are active in the soil-forming processes. The nature of the changes they bring about depends, among other things, upon the kind of life

processes peculiar to each. The kinds of plants and animals that live on and in the soil are determined by the climate, parent material, relief, and age of the soil, and by other organisms.

Most of the soils in the county have developed under a deciduous forest. The principal kinds of trees were oak, hickory, maple, walnut, and elm, but there were several other less important species. Some soils in the county had a native vegetation of tall prairie grasses, and soils that are transitional between those of the timbered areas and those of the prairie areas occur in places. The transitional soils were originally covered by tall prairie grasses and later by forests, and, consequently, they have some of the characteristics of both Gray-Brown Podzolic soils and Brunizems. (See "Classification of the Soils.")

The vegetation has roots that go moderately deep to feed on the plant nutrients in the soil. Most of the trees and shrubs shed their leaves each year. The content of plant nutrients in the leaves varies considerably. Generally, however, deciduous trees return larger amounts of bases and phosphorus to the soil in their leaves than coniferous trees. In this way plant nutrients are returned to the upper part of the soil from the lower part and partly replace nutrients that are leached out by percolating water.

Organic material is added to soils formed under forest by the decay of leaves, twigs, roots, and entire plants. Most of it accumulates on the surface, where it is acted on by micro-organisms, earthworms, and other forms of life and by direct chemical reactions. The plant food released by this decomposition is available for new growth of plants.

Prairie grasses have a dense, fibrous root system that contains a greater number of finer roots than trees and shrubs. The finer roots take less time to decay, and they add more organic matter to the soil than those of forest vegetation. Consequently, the Brunizem soils, which formed under grasses, have darker, thicker surface layers than the soils formed under forest.

As organic material decays, it releases organic acids that hasten the leaching and translocation of inorganic materials. The rate of decomposition is strongly influenced by temperature and by the amount of moisture present.

Parent materials

The parent materials probably have been the most significant soil-forming factor in Boone County. In this county they consist of (1) materials weathered from rock in place, (2) materials transported by glacial action, (3) materials transported by wind (loess), and (4) materials transported by water or gravity (alluvium or colluvium).

The basic geological structure of Boone County (fig. 9) consists of limestone of Mississippian age and shale and sandstone of Pennsylvanian age. After the beds of limestone, shale, and sandstone were laid down, they were exposed to weathering for millions of years. Hills and valleys were formed, and apparently a large stream followed about the present course of the Missouri River.

Weathering of the rock formations produced soil material. The silty shale and sandstone produced similar

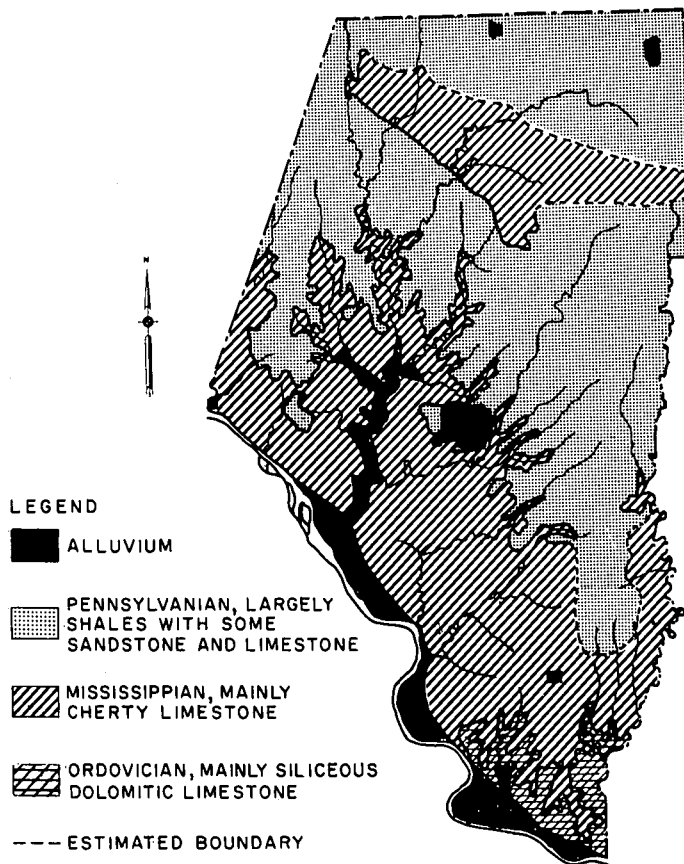


Figure 9.—Main preglacial geological exposures in Boone County.

soil material because the shale contained a lot of silt and the sandstone contained appreciable amounts of finer material. The calcareous clay shale and limestone produced heavy-textured (clayey) soils. The soils of Boone County that formed in these residual materials are those of the Dennis, Gosport, Mandeville, Snead, and Union series. Steep stony land also formed from residual materials.

During Pleistocene time, Boone County was almost completely covered by a glacier of the Kansan glacial age. This huge sheet of ice deposited large amounts of ground-up rock material called glacial till. The deposit was thickest in the northern part of the county; it thinned out to the south near the Missouri River. Borings for wells have indicated a thickness, in places, of more than 100 feet, but in most of the county, the thickness ranges from 10 to 20 feet. The till was derived largely from shale material mixed with some sand and gravel. The material had a high clay content but contained little limestone; it is therefore not so highly calcareous as the till in much of the northern part of the State. As time passed the till was subject to erosion, leaching, and weathering. The soils of Boone County that formed primarily in till are those of the Gamma, Gara, Lindley, and Sapp series.

After the Kansan glacial age, there were two more major glacial ages—first the Illinoian and then the Wisconsin. The farthest extent of their ice sheets was many miles from Boone County. During the melting of the

last ice sheet of the Wisconsin glacial age, large amounts of water flowed down the Missouri River and deposited much finely ground rock material on the flood plains. During the colder spells in winter, when the melting of the ice sheet was checked, the flood plains became dry mudflats. Windstorms then picked up dust from these flats and deposited the larger particles close by, and the finer particles farther away on the uplands. The silty deposits are called loess, which is the material in which most soils of the uplands of Boone County have developed (fig. 10).

The loess was deposited during two or more periods, separated by many years. The lower deposit that is recognized in Boone County is named Loveland loess because it was first recognized near Loveland, Iowa. In only a few places does the Loveland loess occur at the surface as the soil-forming material. Most of the loess that forms the land surface is considered to be Peorian loess. The loess is thickest on the river bluffs and thins out with increasing distance from the bluffs (fig. 11). In places on the bluffs, the loess is more than 30 feet thick, but, over most of the county, it is 5 to 10 feet thick. Where the loess is thick, it covers all of the land surface. Where it thins out, it has been removed from most slopes of 6 percent or more. In intermediate areas, where the loess is generally 5 to 10 feet thick, it does not occur on most of the steeper slopes.

The soils of Boone County that have formed in loess are members of the Hatton, Marion, Menfro, Mexico, Pershing, Putnam, Seymour, Weldon, and Winfield series.

Alluvium was the parent material of many of the soils in the county. The soft loess material of the uplands is very erodible and has been removed from large areas, especially in the northwestern and central parts of Boone County. In some places the eroded material has accumulated at the base of slopes and in narrow drainageways. The soils of the Chauncey series have formed in a mixture of alluvial and colluvial material that was moved mainly by gravity and has accumulated in smaller drainageways in the uplands.

The alluvium in Boone County varies more in texture and color than either the loess or glacial till. Deposits from fast-flowing waters are normally coarse, and those from slow-moving or stagnant waters are fine. It is to be expected that the coarser material will be nearer stream channels, or in small first bottoms, and that the fine-textured material, or gumbo, will be in the larger bottoms, or terraces, generally some distance from the stream channels.

The soils of Boone County that have formed in alluvium are those of the Carlow, Freeburg, Moniteau, Onawa, Racoon, Ray, Salix, Sarpy, Sharon, Stet, Wabash, and Westerville series.

Relief

Relief is important in soil formation because of its influence on drainage, runoff, and infiltration, and other related factors, including accelerated erosion. In Boone County it ranges from nearly level to very steep. On some steep areas where a large amount of water runs off the surface, erosion is rapid and keeps an almost even pace with rock weathering and soil formation. Some of the soils on steep slopes have shallow profiles, and there

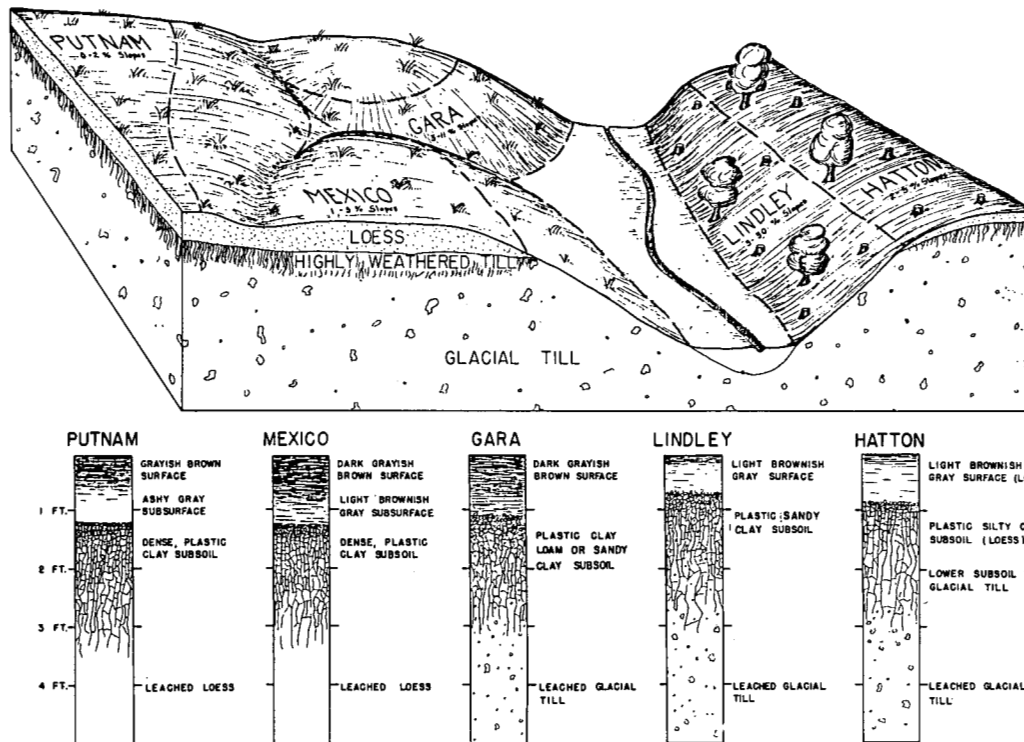


Figure 10.—Relationship of some of the soils of the uplands to parent material, slope, and native vegetation.

are rock outcrops in places. In these areas the soil materials are being constantly removed by erosion. The soils do not remain in place long enough to form horizons.

Drainage is also an important factor that causes differences in soils. The Putnam soils, for example, are in broad, nearly level, prairie areas where drainage is slow. Consequently, they have a highly leached subsurface horizon and a dense subsoil. The Winfield soils, however, are rolling to hilly, have good internal drainage, and are only moderately weathered.

Time

Time is necessary for development of soils from parent materials. Some of the soils in Boone County are old. They have formed in residual soil materials, in glacial till, or in loess, and they have been in place long enough for well-defined horizons to develop. Other soils are young. They are forming near streams where fresh deposits are added from time to time, and they have not been in place long enough for distinct horizons to develop. Some soils are young because they occupy steep slopes, and the soil materials wash away before distinct horizons have had time to form.

Classification of the Soils

Soils can be classified in several ways to bring out their relationship to one another. The simple classification units commonly used in the field are the series, type, and phase. The soil type is the basic classification unit. It consists of soils that are similar in kind, thickness, and arrangement of soil layers.

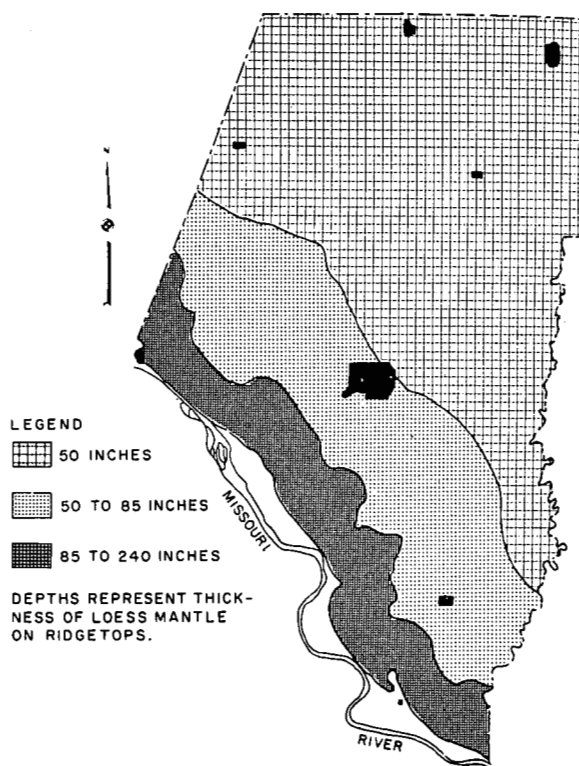


Figure 11.—Thickness of loess in Boone County.

A soil type may consist of several phases. Characteristics that suggest dividing a soil type into phases are variations in slope, degree of erosion, topographic position, and substratum material. The soil phase, or the soil type if it has not been subdivided, is the unit shown on the soil map.

Soil types are grouped into soil series. The soil series consists of one or more soil types. Soil types differ in texture of the surface layer but are otherwise similar in kind, thickness, and arrangement of soil layers. Each series is named for the place near where it was first mapped; for example, the Mexico series is named for Mexico, Mo.

In this report most of the soils have series, type, and phase names. Consider for example, Winfield silty clay loam, 6 to 13 percent slopes, severely eroded. Winfield is the series name; silty clay loam is the type name; and 6 to 13 percent slopes, severely eroded, is the phase designation. A few soils have only the series and type names because they have no significant variations in slope, erosion, or other properties. Stet silt loam is an example.

Soil series are classified by great soil groups. Soils of a great soil group have major features of their profile in common. They have similar horizons, arranged in the same way, but may differ in such characteristics as thickness of profile and degree of development of the different horizons.

Most soil series have characteristics that are representative of one or another of the great soil groups, and they are classified accordingly. A few soil series, however, have some characteristics of two great soil groups. Such soil series are grouped with the great soil group they resemble most closely, but they are classified as intergrading to the other great soil group. For example, soil series that are within the Gray-Brown Podzolic group but that have a thick, dark-colored surface horizon because of the influence of prairie grasses are classified as Gray-Brown Podzolic soils intergrading to Brunizems.

The great soil groups in the county are (1) Gray-Brown Podzolic soils, (2) Brunizems, (3) Planosols, (4) Humic Gley soils, (5) Rendzinas, (6) Lithosols, and (7) Alluvial soils. Miscellaneous land types are not classified by great soil groups. The miscellaneous land types in Boone County are Steep stony land, Riverwash, and Strip mines.

In the highest category of the classification scheme, the great soil groups have been placed in three orders—the zonal, intrazonal, and azonal. The zonal order is made up of soils that have evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. The intrazonal order is comprised of soils with evident, genetically related horizons that reflect the dominant influence of a local factor, such as topography, parent material, or time, over the effects of climate and living organisms. The azonal order is made up of soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent materials, or steep topography.

The classification of the soils in the county is based largely on characteristics observed in the field. It may be revised as knowledge about soil series and their relations increases. In table 13 the soil series are classified according to order and great soil group.

TABLE 13.—*Classification of the soil series by higher categories*

ZONAL ORDER	
Great soil group	Soil series
Gray-Brown Podzolic soils.	Freeburg. Gamma. Hatton. Lindley. Mandeville. Menfro. Pershing (intergrading to Brunizems). Union. Weldon. Winfield.
Brunizems-----	Dennis. Gara (intergrading to Gray-Brown Podzolic soils). Salix (intergrading to Alluvial soils). Seymour (intergrading to Planosols).
INTRAZONAL ORDER	
Planosols-----	Chauncey. Marion. Mexico. Moniteau. Putnam. Raccoon. Sapp.
Humic Gley soils----	Carlow. Stet. Wabash.
Rendzinas-----	Snead.
AZONAL ORDER	
Lithosols-----	Gosport.
Alluvial soils-----	Onawa. Ray. Sarpy. Sharon. Westerville.

Morphology of the Soils by Great Soil Groups

In this section the morphology of the soils of all the series in Boone County is discussed under the great soil groups to which each series belongs. Soil profiles that represent each series are described in the section "Descriptions of the Soils."

Gray-Brown Podzolic soils

The Gray-Brown Podzolic soils belong to the zonal order. These soils, in their virgin state, have a rather thin, organic covering (A_0) and an organic-mineral layer (A_1) that overlie a grayish-brown, leached A_2 horizon. The A_2 horizon rests upon an illuvial, brown B horizon. In Boone County the material underlying the B horizon consists of loessal or alluvial silts, glacial till, or material weathered from limestone or shale.

Gray-Brown Podzolic soils have formed under deciduous trees in a temperate, humid, continental climate. The differences among the typical Gray-Brown Podzolic soils in the county are in color, content of clay, thickness of

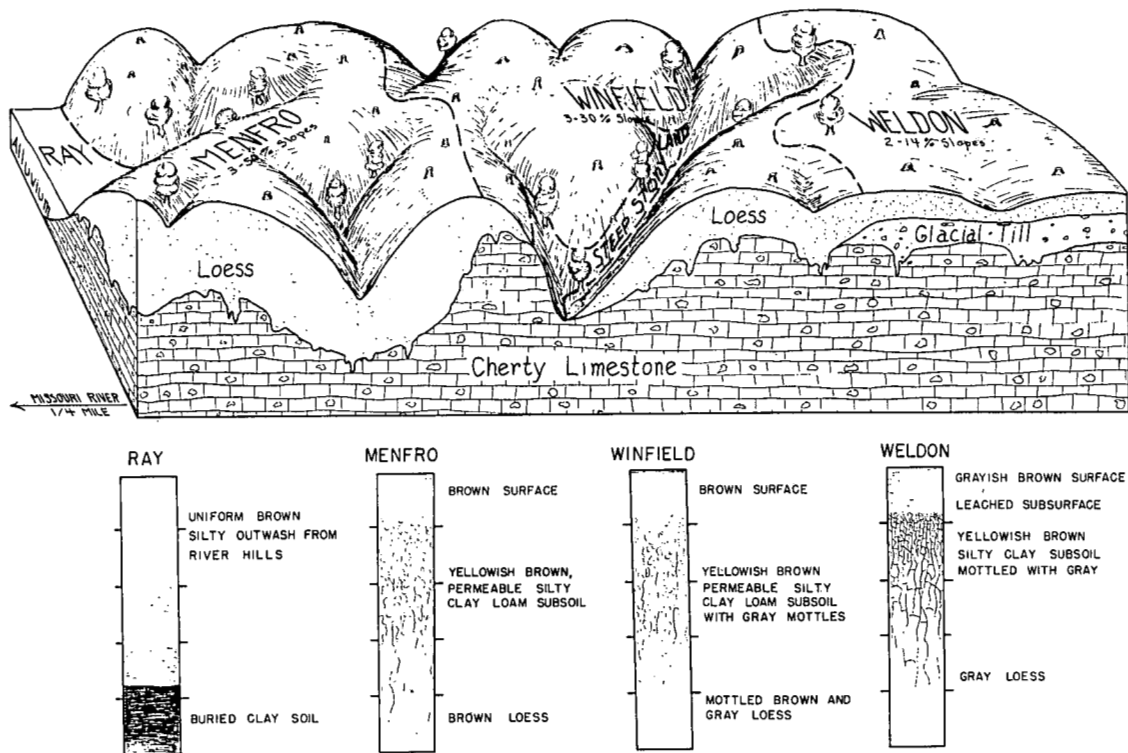


Figure 12.—Relationship of four soil series to parent material, slope, and native vegetation.

horizons, and other characteristics that are chiefly related to the differences in parent materials and topography.

Menfro, Winfield, Weldon, and Hatton series.—The Menfro, Winfield, and Weldon are Gray-Brown Podzolic soils that have formed in loess parent material (fig. 12). Hatton soils also have formed in loess. (See figure 10.) The thickness of the loess has an important bearing on the degree of leaching and profile development.

Menfro and Winfield soils developed in loess that is more than 10 feet thick. They are not highly weathered, as evidenced by the almost uniform color throughout the profile and by the lack of strongly developed horizons. The permeability of the loess and the strongly sloping topography have retarded development of horizons. Carbonates have been leached to a depth of 7 or 8 feet in the Menfro soils and to a depth of 10 or more feet in the Winfield soils. The soils are rich in minerals but are low in organic matter; the amount of organic matter has been reduced by erosion of much of the surface soil. The Winfield soils have developed in thinner loess, have a higher content of clay in the subsoil, and have more distinct horizons than the Menfro soils. In addition, their lower subsoil and underlying material are more mottled with gray and yellow. The Winfield soils are not quite so productive as the Menfro soils.

The Weldon soils formed in loess, 4 to 8 feet thick. They are more highly developed than the Menfro and Winfield soils, as indicated by the higher content of clay in the subsoil and by the development of distinct horizons. The more gentle slopes and slower internal drainage have contributed to the development of distinct horizons in the Weldon soils. The higher content of

clay in the Weldon soils, compared to that in the Menfro soils, is partially due to the smaller size of the loess particles, which were deposited farther from the river.

The Hatton soils developed in loess that is less than 36 inches thick over glacial till. They have horizons that are more distinct than those of the other loess-derived Gray-Brown Podzolic soils. Also, the subsoil is higher in clay content and more highly mottled with gray and yellowish brown. In many places the lower subsoil has developed in glacial till. The Hatton soils are lower in natural fertility and are not so productive as the soils formed in thicker loess.

Gamma and Lindley series.—The Gamma and Lindley soils are Gray-Brown Podzolic soils that have formed primarily in glacial till. On many of the slopes in the northwestern and central parts of the county, much of the loess has been removed by erosion. As a result, till is exposed or is at a very shallow depth.

The Gamma soils formed in glacial till that contained more sand than that in which other till-derived soils formed. The subsoil is reddish brown, in contrast to the yellower subsoil of the Lindley soils. Gamma soils developed under timber.

The morphological features of the Lindley soils are the moderate profile development and the high content of clay in the subsoil. The high clay content of the weathered till and the movement of clay from the upper layer into the subsoil account for the large amount of clay in the subsoil. The content of clay tends to increase with depth. There is considerable variation in the color, texture, and distinctness of horizons because of the variable composition of the till. The light color and relative

shallowness of the surface soil are attributed to the original cover of forest and to the effects of erosion. Lindley soils are low in natural fertility and in productivity.

Mandeville and Union series.—The Mandeville and Union soils are Gray-Brown Podzolic soils that have formed in residual material.

The Mandeville soils have formed in material weathered from acid shale, sandstone, and a few thin seams of coal. In general appearance and in productivity, these soils resemble the till-derived Lindley soils. They occur on similar topography. On some of the steeper slopes, the subsoil may consist of partly weathered shale.

The Union soils have formed in material weathered from limestone. In most places the mantle of soil material is several feet thick, but, in a few places, there are ledges of rock at the surface. The soil material in which the Union soils have formed has a reddish-brown color that distinguishes it from the lighter colored loess and till. The lower subsoil generally contains a fragipan that, in places, is 15 inches thick. It is almost impermeable to moisture and to penetration by roots. As mapped in Boone County, some areas of Union soils do not have a fragipan. Where the lower subsoil is near limestone, it may be a red clay. In some places it may be a brown, cherty silty clay. In many places where the soil mantle is thick, the lower subsoil is yellowish brown and has gray mottles.

Freeburg series.—The Freeburg soils are Gray-Brown Podzolic soils that have developed in alluvial silts on terraces. In Boone County the Freeburg soils have a darker surface soil than normal. The A₁ horizon is very dark grayish-brown silt loam, and it overlies an A₂ horizon of gray silt loam. The B horizon is gray silty clay loam.

Pershing series.—The Pershing soils have the characteristics of Gray-Brown Podzolic soils but also have characteristics similar to those of the Brunizems. Therefore, they have been classified as Gray-Brown Podzolic soils intergrading to Brunizems. Originally, the Pershing soils were covered by prairie grasses, but later trees invaded the areas and influenced the development of the soils. These soils have a moderately well developed A₂ horizon as a result of this forest influence.

Brunizems

The Brunizems, or Prairie soils, belong to the zonal order. They have formed in a temperate, humid, continental climate under a cover of tall grasses. Typically, these soils have a dark-colored A₁ horizon. There is a gradual transition from the A to the B horizon, and the B₂ horizon has a brown or yellowish-brown matrix that is commonly mottled with gray. Clay has accumulated in the B horizon. The Dennis, Gara, Salix, and Seymour soils of Boone County are classified in the Brunizem great soil group.

Dennis series.—The Dennis soils developed in residual material weathered from limestone and are slightly darker than the Seymour soils.

Gara series.—In common with the Pershing soils of the Gray-Brown Podzolic group, the Gara soils developed under an original cover of prairie grasses that subsequently gave way to an invasion of trees. Profiles of Gara soils show the influence both of grasses and of trees,

so these soils are classified as Brunizems intergrading to the Gray-Brown Podzolic group.

Salix series.—Salix soils developed in dark, medium-textured material high in organic matter. At a depth below about 36 inches, the material may contain a considerable amount of sand.

Seymour series.—The Seymour soils developed in loess that is 8 or more feet thick. They are not highly weathered, and their soil horizons are not so strongly differentiated as those of the Gray-Brown Podzolic soils or the Planosols. In Boone County the Seymour soils are considered to intergrade to the Planosol great soil group because of the fine texture and slow permeability of the B horizon.

Planosols

The Planosols belong to the intrazonal order. They have eluviated surface and subsurface horizons underlain abruptly by B horizons that are more strongly illuviated or compacted than those of other great soil groups. The firm to very firm, very fine textured B₂ horizon, commonly called a claypan, restricts the movement of water and the penetration of roots. The Planosols in Boone County are the Chauncey, Marion, Mexico, Moniteau, Putnam, Racoon, and Sapp soils. These soils have developed in loess, in alluvium, and in glacial till.

Chauncey series.—The Chauncey soils occur in small upland drainageways where soil material has washed from adjacent, sloping prairie soils. They have a moderately dark A₁ horizon, about 18 inches thick, overlying a gray A₂ horizon that is as much as 18 inches thick. The claypan is similar to that of Putnam silt loam and begins at a depth ranging from 30 to 40 inches.

Marion, Mexico, and Putnam series.—The Marion soils occupy almost level ridges and are surrounded by Lindley soils. Locally, the areas of Marion soils are called post-oak ridges and have developed in thin loess underlain by glacial till. The native vegetation was trees. Marion soils have prominent A₂ and B₂ horizons and are highly weathered.

The Mexico soils developed in loess, 4 to 5 feet thick, underlain by glacial till that has a high content of clay. Because of the thicker loess and gentle slopes, Mexico soils are not so highly weathered as the Marion soils. They developed under grass and have a higher content of organic matter and are more fertile than Marion soils.

Morphologically, the Mexico soils and the Putnam soils are among the most distinct soils in the county. Both developed in similar parent material and under similar vegetation. They have formed in comparatively thin loess and are more highly leached and more strongly developed than the Menfro and Winfield soils, which have formed in thick loess. In the Mexico and Putnam soils, silicate clay minerals and some organic matter have moved from the A horizon into the B horizon, and, as a result, the solum is well developed. This translocation of minerals is most pronounced in the level areas.

Retarded drainage in the A₂ horizon above the claypan has caused a reduction of iron and its segregation into concretions. The reduction and removal of iron has caused the characteristic gray color of this horizon.

The primary differences between the Mexico and the Putnam soils are in the color and thickness of the A₂ horizon. Mexico soils are sloping enough to provide better drainage; consequently, their A₂ horizon is not so thick, contains fewer iron concretions, and generally is browner than that of the Putnam soils. In some areas of the Mexico soils where forest invaded the prairie, the surface layer is slightly grayer and the soil is called a light-gray variant.

Moniteau and Racoon series.—The Moniteau and Racoon soils are Planosols that have developed in alluvium on high bottoms and terraces. They have a distinct A₂ horizon underlain by B horizons that are high in content of clay. The Racoon soils have a darker surface soil than Moniteau soils and generally have a thicker A₂ horizon.

Sapp series.—Sapp soils have developed in glacial till of heavy, plastic clay. They have a thin silt loam A₁ horizon, generally about 5 inches thick. The thin, distinct A₂ horizon is only about 3 inches thick and is underlain abruptly by a B₂ horizon of plastic clay.

Humic Gley soils

Humic Gley soils belong to the intrazonal order. They are poorly drained and have a thick surface horizon and a highly gleyed subsoil. In Boone County they have developed in depressional areas in the bottom lands where water tends to pond and internal drainage is very poor. The Carlow, Stet, and Wabash soils are in the Humic Gley great soil group. They have developed in alluvial material, mainly under swamp grass.

Carlow, Stet, and Wabash series.—The Carlow soils have developed from dark-gray, fine-textured sediments and are poorly drained, even though they occur on fairly high bottom lands. The Stet soils are generally slightly coarser textured than the Wabash soils, and the dark color may extend deeper into the profile.

Rendzinas

The Rendzinas belong to the intrazonal order. They have a very dark brown to black surface layer underlain by dark-gray to olive-brown calcareous material. Partly weathered limestone and shale may occur within a depth of 2 feet. In Boone County the Snead soils are in the Rendzina great soil group.

Snead series.—Snead soils are only slightly weathered and lack a B horizon. Their dark color is attributed to the accumulation of organic matter in the presence of lime. The variability in color and in quantity of stones is due to the different kinds of parent rocks. In some places where shale predominates, the material below the surface layer is yellowish brown.

Lithosols

Lithosols are azonal soils that have little or no clearly expressed soil morphology. They consist of a freshly or imperfectly weathered mass of soil fragments and are confined largely to hilly and steep areas. Included in this great soil group are soils that are very shallow over bedrock and have very weakly developed profiles. Geologic erosion almost keeps pace with the weathering of the rocks. In Boone County the Gosport soils are classified as Lithosols. Many small areas within the miscellaneous land type mapped as Steep stony land also

have characteristics typical of the Lithosol great soil group.

Gosport series.—The Gosport soils are light colored, are generally medium textured, and contain variable amounts of stones. Bedrock generally occurs at a depth of 4 to 18 inches.

Alluvial soils

The Alluvial great soil group belongs to the azonal order. The soils are developing in transported and recently deposited alluvial material. They have little or no profile development and receive fresh deposits of sediments during occasional floods. The profile characteristics of these soils are determined largely by the kinds of sediments deposited. In Boone County the Onawa, Ray, Sarpy, Sharon, and Westerville soils belong to the Alluvial great soil group.

Onawa series.—The Onawa soils are forming in dark-colored, fine-textured sediments, but they generally have good underdrainage because they are underlain by sandy materials.

Ray series.—The Ray soils are developing in recent deposits of alluvium washed from the deep-loess areas. They are well drained and uniformly brown to a depth of 12 to 36 or more inches. At a greater depth, they are underlain, in many places, by older, darker alluvial material of variable texture.

Sarpy series.—Sarpy soils are forming in sandy materials deposited near stream channels. The surface soil ranges in texture from loose sand to very fine sandy loam. The soils are excessively drained and are subject to wind erosion.

Sharon series.—The Sharon soils are forming in light-colored, medium-textured material deposited along the smaller streams. They are well drained and, in places, are underlain by sandy material. In some areas adjacent to stony soils of the uplands, the Sharon soils are underlain by gravelly material, generally at a depth below about 30 inches.

Westerville series.—Westerville soils are forming in light-colored, medium-textured material deposited along the small streams. They are not so well drained as the Sharon soils. Their yellowish-brown soil material is mottled with gray below a depth of about 12 inches. In some places the Westerville soils are moderately sandy or contain bands and streaks of very fine sand.

Laboratory Analyses

More than 40 percent of the area of Boone County is covered with a surface mantle of loess. Differences in thickness of loess are related to differences in the soils. Menfro soils have developed in the thickest loess, Weldon soils in thinner loess, and Winfield soils in loess intermediate in thickness. With decreasing thickness of the loess, the clay content of the subsoil increases and the depth to the maximum accumulation of clay decreases (fig. 13). Differences in clay content and other differences in the Menfro, Weldon, and Winfield soils are shown in the laboratory data given in table 14.

Analyses of Putnam silt loam and Seymour silt loam are given in tables 15 and 16, respectively. The thickness of the loess in the Putnam soils is about 50 inches, and, in the Seymour soils, it is about 69 inches. Both

TABLE 14.—*Partial mechanical and chemical analyses of profiles of three soil types*

Soil type	Depth from surface	Clay (less than 0.002 mm.)	Exchange capacity	Organic matter	pH
	<i>Inches</i>	<i>Percent</i>	<i>Milliequivalents per 100 grams</i>	<i>Percent</i>	
Menfro silt loam-----	0 to 5	9.9	6.5	1.6	7.2
	5 to 10	10.5	7.2	.9	6.2
	10 to 18	18.8	8.4	.3	4.7
	18 to 24	25.4	12.9	.5	4.8
	24 to 30	29.6	14.3	.3	4.8
	30 to 36	31.2	16.4	.2	5.2
	36 to 40	30.7	20.7	.1	5.2
	40 to 48	27.7	16.5	.2	5.3
	48 to 60	25.8	17.4	.2	5.4
	60 to 72	24.9	17.4	.1	5.5
	72 to 84	23.0	17.0	.0	5.9
	84 to 88	21.6	-----	.0	5.8
Winfield silt loam-----	0 to 1½	13.9	11.95	4.8	6.0
	4 to 7	13.9	8.24	.7	4.6
	9½ to 12	15.2	8.41	.4	4.6
	15 to 18	16.3	9.11	.2	4.6
	21 to 24	24.5	15.81	.1	4.7
	27 to 30	36.0	25.0	.2	4.4
	34 to 37	32.4	-----	.0	4.9
	45 to 50	26.3	19.89	.0	6.0
	54 to 61	24.0	19.65	.0	7.1
	65 to 78	19.8	16.52	.1	7.5
Weldon silt loam-----	0 to 12	13.7	7.9	1.5	4.7
	12 to 18	14.7	6.7	.6	5.1
	18 to 24	42.9	24.5	.1	5.2
	24 to 36	33.8	18.1	-----	6.0
	36 to 48	27.6	16.1	-----	6.2
	48 to 60	24.1	16.1	-----	6.8
	60 to 72	26.0	13.6	-----	6.8

TABLE 15.—*Partial mechanical and chemical analysis of a profile of Putnam silt loam*

Depth from surface	Clay (less than 0.002 mm.)	Exchange capacity	Exchangeable bases	Base saturation
<i>Inches</i>	<i>Percent</i>	<i>Milliequivalents per 100 grams</i>	<i>Milliequivalents per 100 grams</i>	<i>Percent</i>
0 to 3-----	20.5	22.0	13.5	61.4
3 to 6-----	20.1	17.6	9.8	55.7
6 to 10-----	21.7	16.0	7.3	45.6
10 to 14-----	26.3	17.5	7.7	44.0
14 to 18-----	42.2	29.0	13.1	45.2
18 to 22-----	57.7	40.1	23.0	57.4
22 to 26-----	51.3	37.2	23.2	62.4
26 to 30-----	41.4	32.9	22.8	69.3
30 to 34-----	37.0	30.6	23.0	75.2
34 to 38-----	36.3	29.7	23.9	80.5
38 to 42-----	24.7	29.8	24.1	80.9
42 to 46-----	33.4	27.3	22.7	83.2
46 to 52-----	29.1	20.5	16.8	82.0
52 to 58-----	23.0	14.5	11.9	82.1
58 to 64-----	24.7	13.9	12.4	89.2

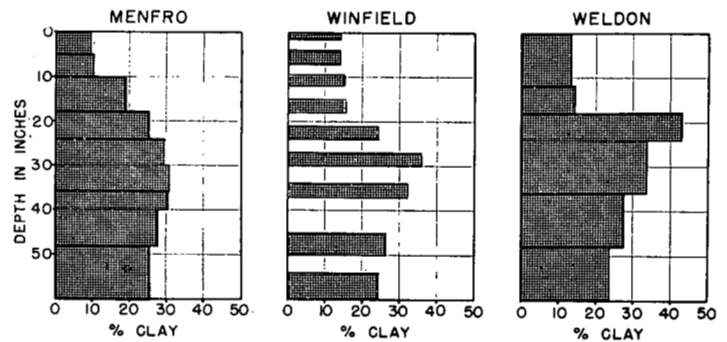


Figure 13.—Content of clay in three soils derived from loess. The native vegetation of the soils is forest. The loess is more than 10 feet thick in the Menfro soils, 7 to 10 feet thick in the Winfield soils, and about 5 feet thick in the Weldon soils.

soils formed under grass. The Putnam soils are nearly level, but the Seymour soils are rolling. The content of clay is greater in the subsoil of the Putnam soils, and the depth to the zone of maximum accumulation of clay is less.

TABLE 16.—*Mechanical analysis of a profile of Seymour silt loam*

Depth from surface	Sand (greater than 0.046 mm.)	Silt (0.046-0.002 mm.)	Clay (less than 0.002 mm.)
<i>Inches</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
0 to 12-----	6.43	75.41	15.58
12 to 17-----	7.41	72.01	21.78
17 to 22-----	4.09	58.84	38.78
22 to 32-----	3.65	64.71	41.03
32 to 42-----	3.93	65.91	36.07
42 to 55-----	3.48	71.51	34.21
55 to 63-----	4.32	71.45	28.33
63 to 69-----	4.70	70.78	27.23
69 to 75-----	4.59	74.73	26.25
108 to 114-----	10.77	56.34	34.39

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GUIDE TO MAPPING UNITS AND CAPABILITY UNITS

Map symbol	Soil name	De- scribed on page	Capa- bility unit	De- scribed on page
Ca	Carlow silty clay, high-bottom phase.....	4	IIIw-14.....	23
Cb	Chauncey silt loam, 0 to 1 percent slopes.....	5	IIIw-3.....	23
Da	Dennis silt loam, 3 to 7 percent slopes.....	6	IIIe-1.....	22
Fa	Freeburg silt loam, dark-surface variant.....	6	IIIe-5.....	22
Ga	Gamma soils, 5 to 8 percent slopes.....	6	IIIe-6.....	23
Gb	Gamma soils, 9 to 12 percent slopes.....	6	IVe-6.....	24
Gc	Gara loam, 5 to 8 percent slopes.....	7	IIIe-6.....	23
Gd	Gara loam, 5 to 9 percent slopes, moderately eroded.....	7	IIIe-6.....	23
Ge	Gara clay loam, 5 to 9 percent slopes, severely eroded.....	7	IVe-6.....	24
Gf	Gosport stony silt loam, 11 to 30 percent slopes.....	7	VIIIs-6.....	25
Ha	Hatton silt loam, 3 to 7 percent slopes.....	7	IIIe-6.....	23
La	Lindley loam and clay loam, 5 to 8 percent slopes.....	8	IVe-6.....	24
Lb	Lindley loam and clay loam, 9 to 15 percent slopes.....	8	VIIe-1.....	25
Lc	Lindley loam, 16 to 25 percent slopes.....	8	VIIe-6.....	25
Ma	Mandeville silt loam, 5 to 8 percent slopes.....	8	IVe-2.....	24
Mb	Mandeville silt loam and silty clay loam, 9 to 16 percent slopes.....	8	VIIe-1.....	25
Mc	Marion silt loam, 1 to 3 percent slopes.....	9	IIIw-3.....	23
Md	Menfro silt loam, terrace phase, 1 to 3 percent slopes.....	9	Ile-1.....	22
Me	Menfro silt loam and silty clay loam, 6 to 13 percent slopes.....	9	IIIe-1.....	22
Mf	Menfro silt loam and silty clay loam, 14 to 19 percent slopes.....	9	IVe-1.....	24
Mg	Menfro silt loam and silty clay loam, 20 to 50 percent slopes.....	9	VIe-1.....	25
Mh	Mexico silt loam, 1 to 3 percent slopes.....	10	IIIe-5.....	22
Mk	Mexico silt loam, 2 to 4 percent slopes, moderately and severely eroded.....	10	IVe-5.....	24
MI	Mexico silt loam, light-gray variant, 1 to 3 percent slopes.....	10	IIIe-5.....	22
Mm	Moniteau silt loam.....	11	IIIw-1.....	23
Oa	Onawa silty clay loam.....	11	IIw-1.....	22
Ob	Onawa silty clay.....	11	IIw-1.....	22
Pa	Pershing silt loam, 2 to 4 percent slopes.....	11	IIIe-5.....	22
Pb	Putnam silt loam, 0 to 2 percent slopes.....	12	IIIw-3.....	23
Ra	Raccoon silt loam, 1 to 3 percent slopes.....	12	IIIw-3.....	23
Rb	Ray silt loam.....	12	I-1.....	22
Rc	Riverwash.....	13	VIIIs-1.....	25
Sa	Salix loam.....	13	I-1.....	22
Sb	Sapp soils, 3 to 5 percent slopes.....	13	IVe-5.....	24
Sc	Sarpy sand.....	13	IVs-4.....	24
Sd	Sarpy loamy fine sand.....	14	IIIs-1.....	23
Se	Sarpy very fine sandy loam.....	14	I-1.....	22
Sf	Seymour silt loam, 2 to 4 percent slopes.....	14	IIIe-5.....	22
Sg	Seymour silt loam, 3 to 7 percent slopes, moderately eroded.....	14	IIIe-5.....	22
Sh	Sharon silt loam.....	14	I-1.....	22
Sk	Sharon silt loam, gravel-substratum variant.....	15	IIIs-1.....	23
Sl	Snead silty clay, 7 to 12 percent slopes.....	15	IVe-2.....	24
Sm	Snead stony clay loam, 11 to 30 percent slopes.....	15	VIIIs-6.....	25
Sn	Steep stony land, 15 to 50 percent slopes.....	15	VIIIs-6.....	25
So	Stet silt loam.....	15	IIIw-1.....	23
Sp	Strip mines.....	15	VIIIs-1.....	25
Ua	Union silt loam, 3 to 8 percent slopes.....	16	IIIe-6.....	23
Ub	Union silt loam and silty clay loam, 9 to 16 percent slopes.....	16	VIe-1.....	25
Wa	Wabash silty clay loam.....	16	IIw-1.....	22
Wb	Wabash clay.....	16	IIIw-14.....	23
Wc	Weldon silt loam, 2 to 4 percent slopes.....	17	IIIe-5.....	22
Wd	Weldon silt loam, 2 to 4 percent slopes, moderately eroded.....	17	IVe-5.....	24
We	Weldon soils, 5 to 11 percent slopes.....	17	IVe-5.....	24
Wf	Westerville silt loam.....	17	IIIw-1.....	23
Wg	Winfield silt loam, 6 to 13 percent slopes.....	17	IIIe-6.....	23
Wh	Winfield silty clay loam, 6 to 13 percent slopes, severely eroded.....	18	IVe-6.....	24
Wk	Winfield soils, 14 to 19 percent slopes.....	18	VIe-1.....	25
WI	Winfield soils, 20 to 30 percent slopes.....	18	VIIe-6.....	25



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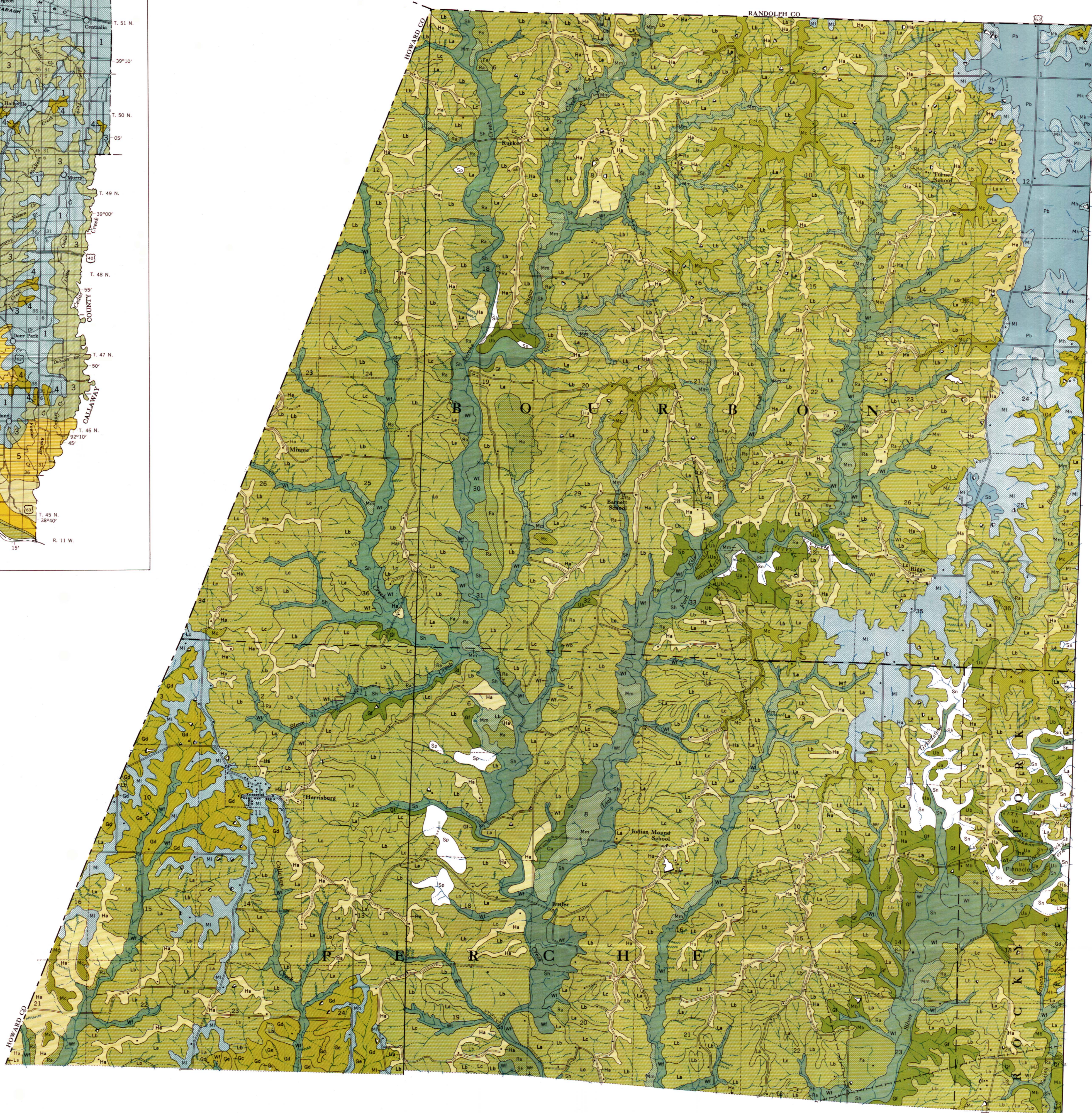
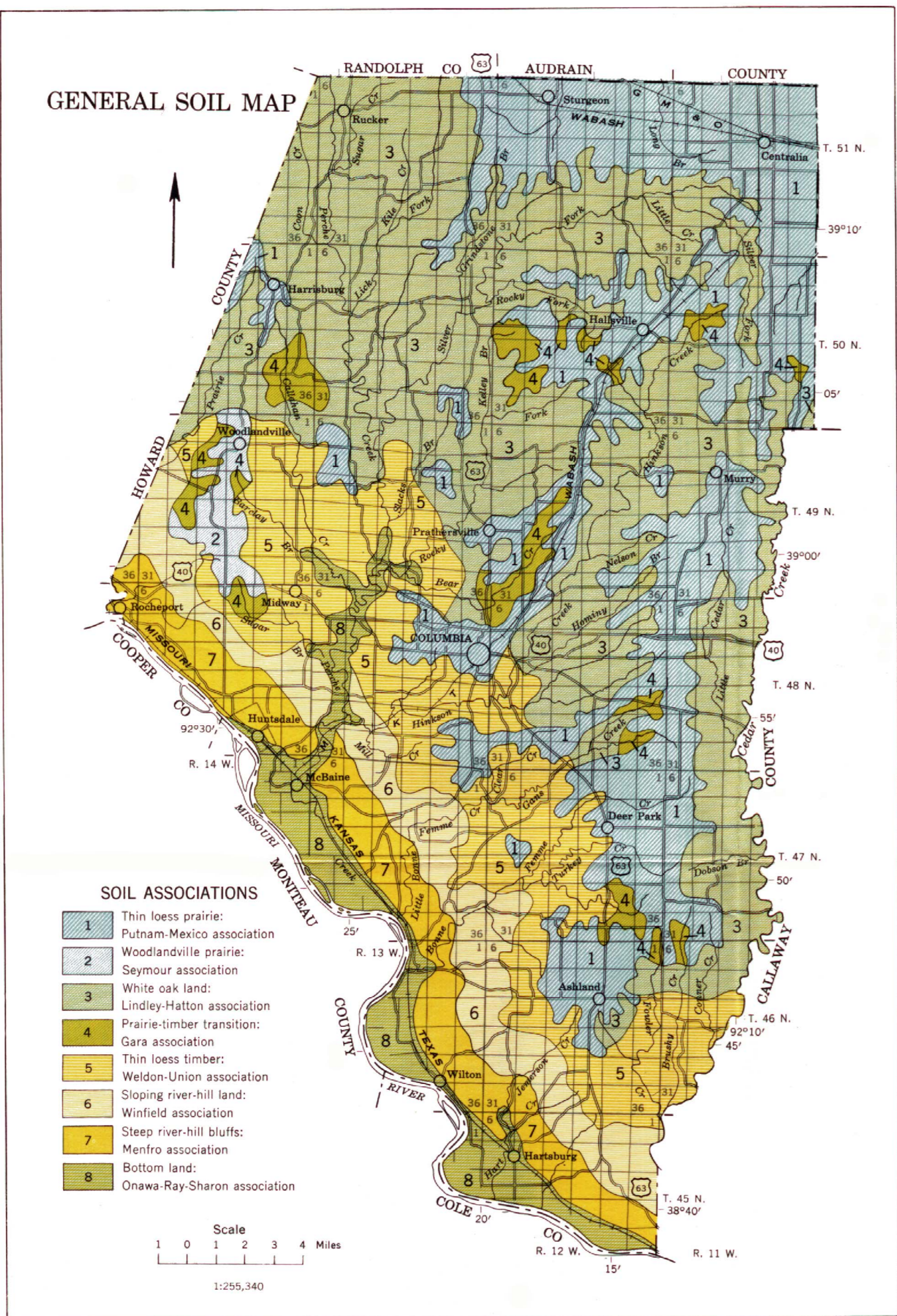
program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

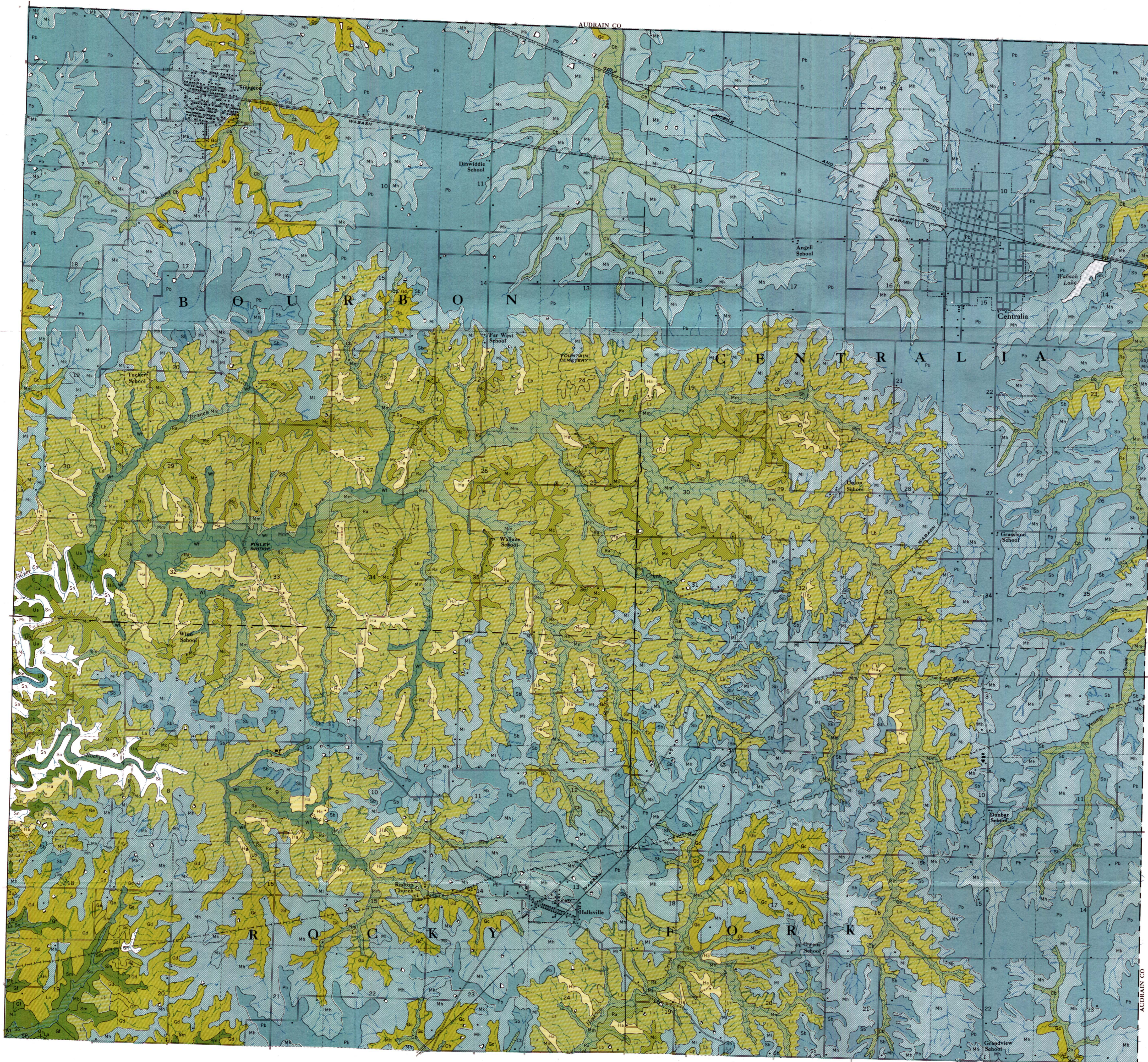
Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (<http://directives.sc.egov.usda.gov/33085.wba>).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (<http://directives.sc.egov.usda.gov/33086.wba>).

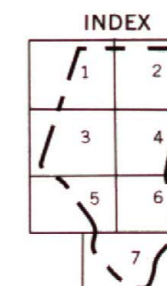
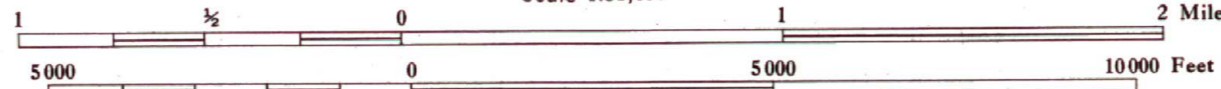




Correlation and inspection by William D. Shrader
and Guy D. Smith, U. S. Department of Agriculture.
Soils surveyed 1947-50 by M. E. Springer and
C. L. Scrivner, in Charge, and J. A. Friesa,
Missouri Agricultural Experiment Station.

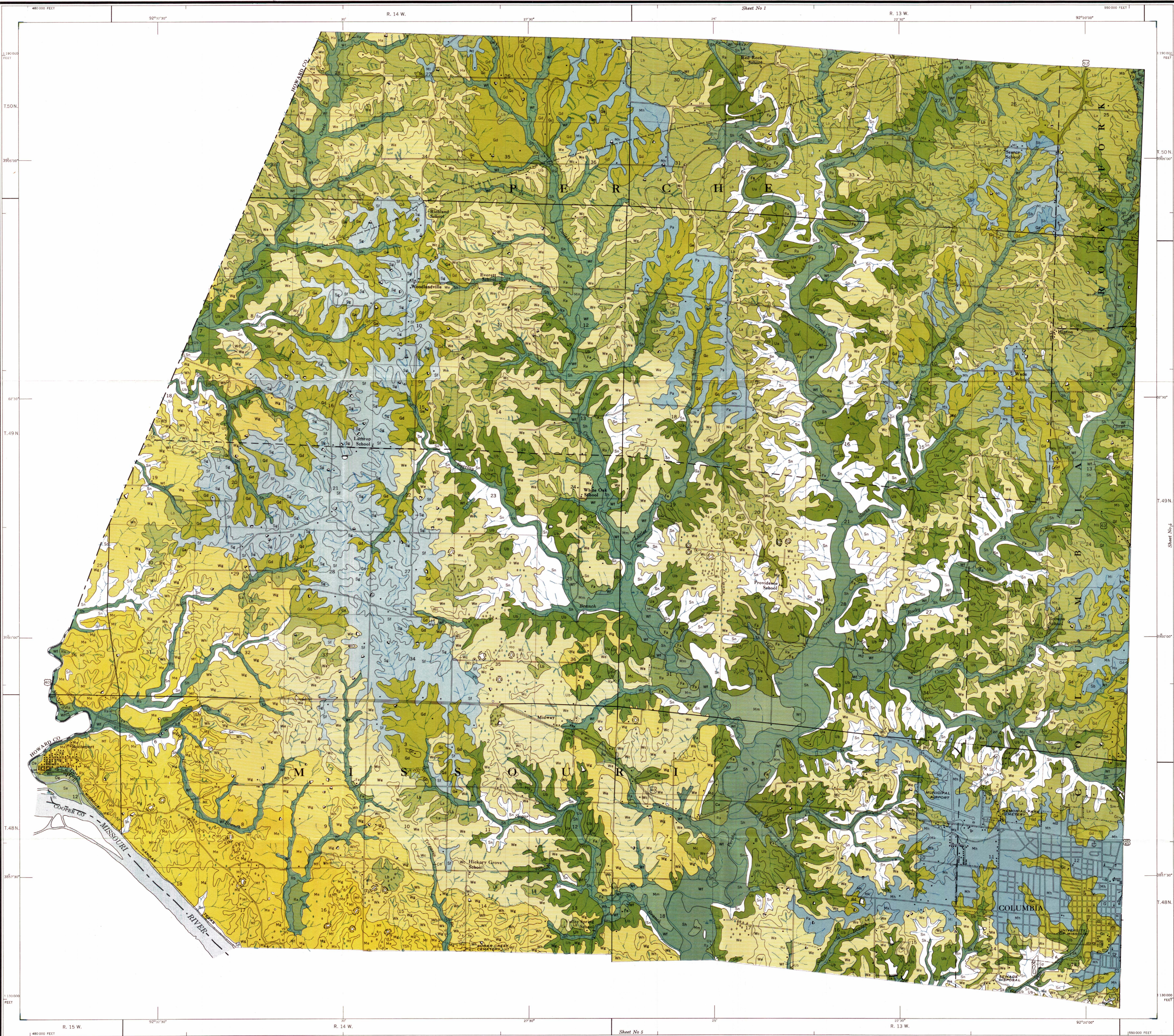
Sheet No. 2

Scale 1:31,680



See Sheet No. 5 for Alphabetical Legend,
Color Grouping, and Conventional Signs.

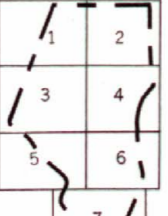
Map constructed by Cartographic Division,
Soil Conservation Service, USDA,
from 1939 aerial photographs.
Soils surveyed on 1939 aerial photographs.
Polyconic projection, 1927 North American datum.
10,000-foot grid based on Missouri
(Central) rectangular coordinate system.



Correlation and inspection by William D. Shrader and Guy D. Smith, U. S. Department of Agriculture. Soils surveyed 1947-50 by M. E. Springer and C. L. Schriener, in charge, and J. A. Friese, Missouri Agricultural Experiment Station.

Scale 1:31,680
1 1/2 0 1 2 Miles
5000 0 5000 10000 Feet

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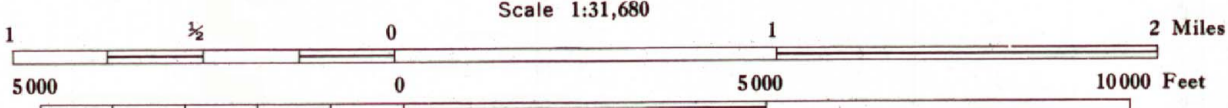


See Sheet No 5 for Alphabetical Legend, Color Grouping, and Conventional Signs.

Map constructed by Cartographic Division, Soil Conservation Service, USDA, from 1939 aerial photographs. Soils surveyed on 1939 aerial photographs. Polyconic projection, 1927 North American datum. 10000-foot grid based on Missouri (Central) rectangular coordinate system.



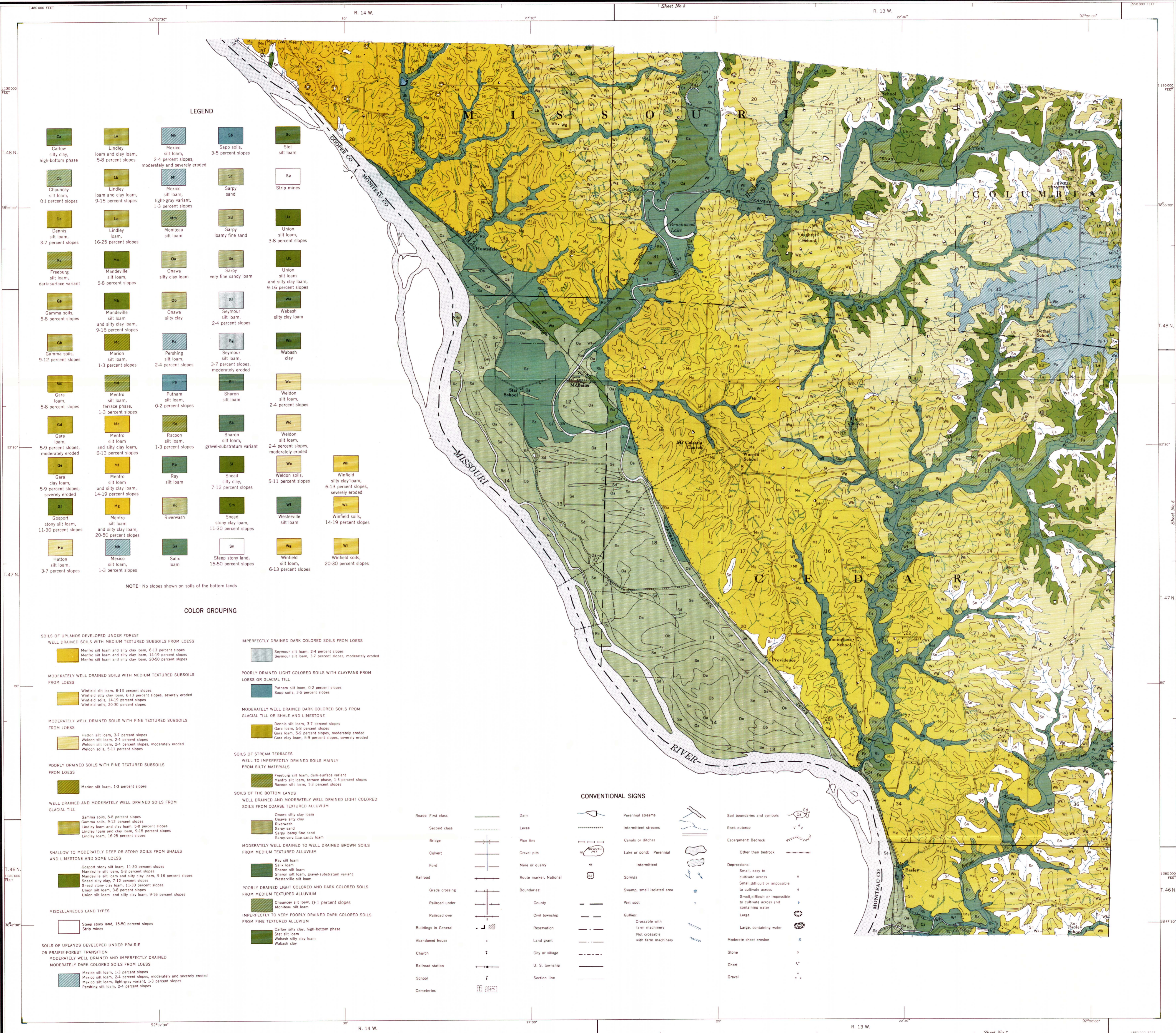
Correlation and inspection by William D. Shrader
and Guy D. Smith, U. S. Department of Agriculture.
Soils surveyed 1947-50 by M. E. Springer and
C. L. Schriener, in charge, and J. A. Friesz,
Missouri Agricultural Experiment Station.

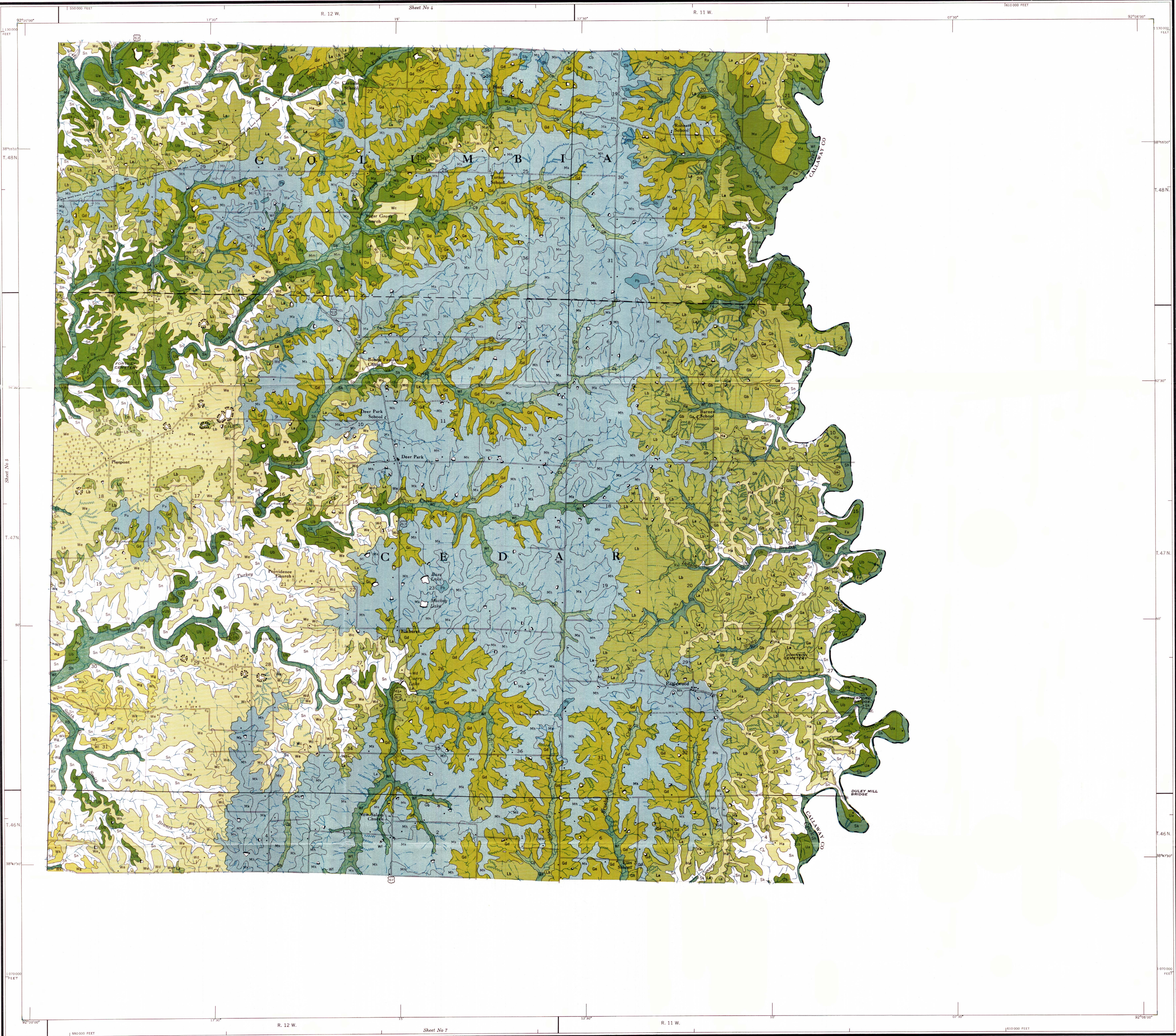


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1	2
3	4
5	6

See Sheet No 5 for Alphabetical Legend,
Color Grouping, and Conventional Signs.

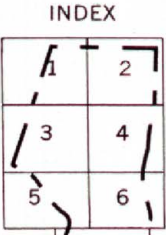
Map constructed by Cartographic Division,
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Soils surveyed on 1939 aerial photographs.
Polyconic projection, 1927 North American datum.
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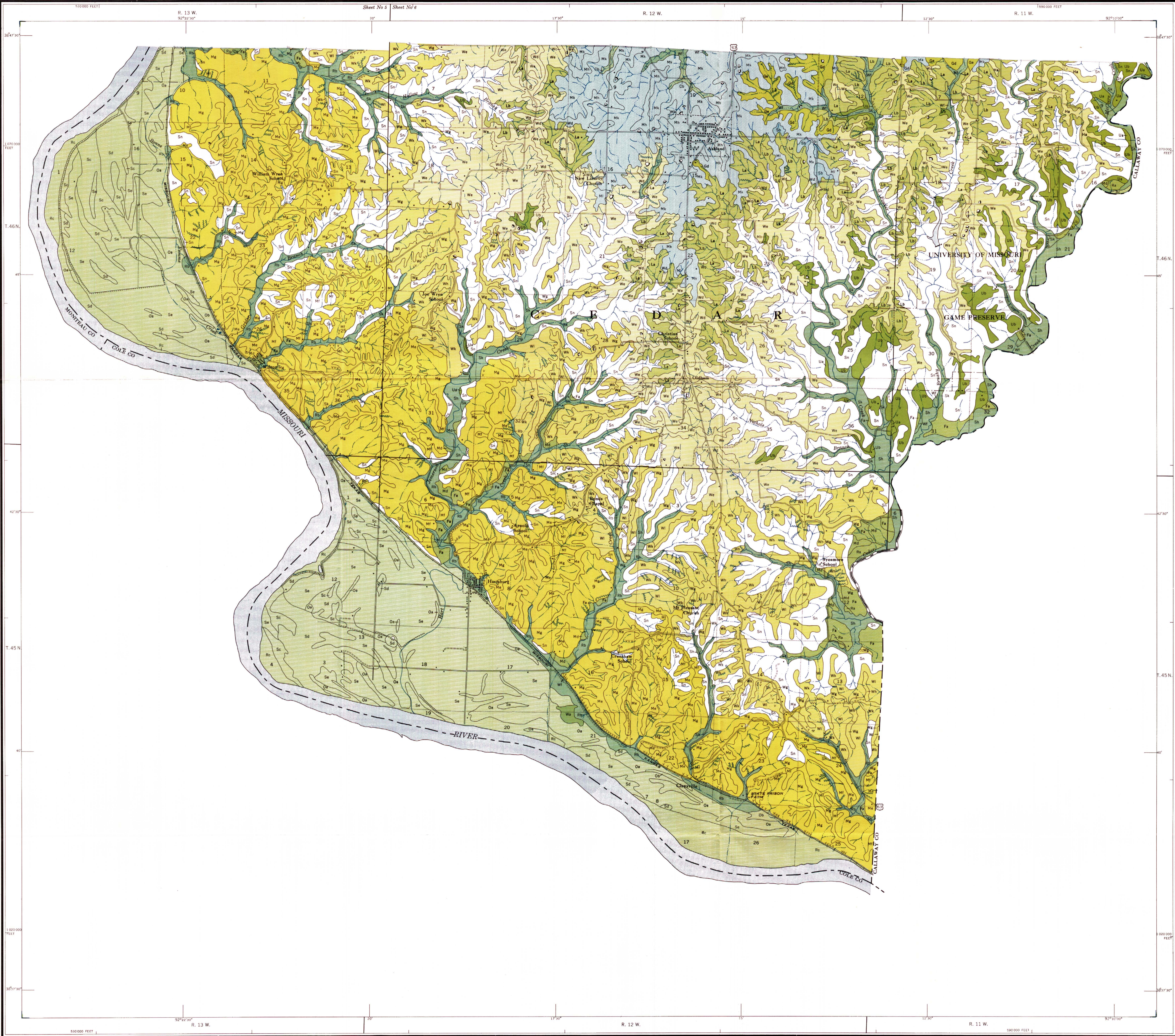
Correlation and inspection by William D. Shrader
and Gay D. Smith, U. S. Department of Agriculture.
Soils surveyed 1947-50 by M. E. Springer and
C. L. Sawyer, in charge, and J. A. Fries,
Missouri Agricultural Experiment Station.

Scale 1:31,680
1 1/2 0 1 2 Miles
5000 0 5000 10000 Feet

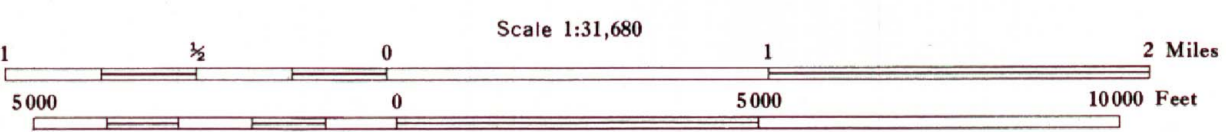


See Sheet No 5 for Alphabetical Legend,
Color Grouping, and Conventional Signs.

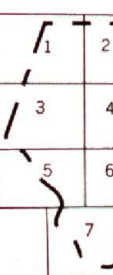
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Soils surveyed 1947-50 by M. E. Springer and
C. L. Scrivner, in charge, and J. A. Friesz,
Missouri Agricultural Experiment Station.



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See Sheet No. 8 for Alphabetical Legend,
Color Grouping, and Conventional Signs.

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Soil Conservation Service, USDA,
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Soils surveyed on 1939 aerial photographs.
Polyconic projection, 1927 North American datum.
10,000-foot grid based on Missouri
(Central) rectangular coordinate system.